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Title

Facilitating healthcare transformation: Exploring the factors propelling and hindering blockchain adoption decision

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Abstract

This paper outlines the findings from the research investigating the factors propelling and hindering the blockchain adoption decisions in the healthcare sector. The research uses the exploratory research approach drawing on documentary and empirical data, for example, official reports published by international and regional organizations and in-depth semi-structured interviews with relevant healthcare sector stakeholders. This study utilised Lewin's Force field analysis (1951) and Tornatzky and Fleischer's (1990) TOE (technology, organization, and environment) framework as the theoretical lens to identify these factors. The analysis of the driving forces revealed that the perceived usefulness is comparatively the most potent force compared to the others. On the contrary, resource availability is the weak force to impact the blockchain adoption decision, particularly in developing countries like Bangladesh. Subsequently, the analysis of the restraining forces revealed that insufficient technological infrastructure is the main technical concern regarding blockchain technology adoption decisions, and the technical and non-technical concerns are closely related. Theoretically, the findings of this study will supplement the analysis of the blockchain readiness studies in healthcare as it bridged the knowledge gap and distinguished the prevailing driving and restraining forces that influence the adoption decision of the stakeholders. Empirically, this knowledge will facilitate the efficient implementation of blockchain technology in the healthcare sector, particularly in developing countries.

Keywords: Blockchain, healthcare, driving forces, restraining blocks, technology adoption decision.

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1. Introduction

The healthcare sector has a direct impact on people's quality of life; therefore, it always attains great social importance (Roman-Belmonte, De la Corte-Rodriguez and Rodriguez-Merchan, 2018). In the healthcare sector, data security and privacy are very crucial because protecting patients' health related data is a legal and ethical concern for the hospitals (McGhin et al., 2019).

In recent times, blockchain technology has emerged as a reliable and potential solution for data privacy, security, and integrity issues in healthcare (Yaeger et al., 2019; Engelhardt, 2017; Lee & Pilkington, 2017; Rawal, 2018; Yli-Huumo et al., 2016). It is known as a distributed ledger technology consisting of consecutive blocks chained together and distributed in a peer-to-peer (P2P) network, allowing data to be stored in a reliable and verifiable way (Gaggioli, 2018). Several researchers have already addressed the potential of blockchain technology to overcome existing challenges and enhance the performance of the healthcare sector (Zhang et al., 2018; Liang et al., 2017; Sullivan and Burger, 2017).

However, the application of blockchain technology could have a disruptive effect at all levels of an organisation (Sarkar, 2018). It transforms communications between organisations because it allows organisations to store data externally and share them more easily with partners (Dai and Vasarhelyi, 2017). Also, blockchain technology implementation in any sector involves cooperation from stakeholders, change in governance and acceptability are important for its success (Hou, 2017; Konashevych, 2017; Ølnes and Jansen, 2017; Ølnes, Ubacht and Janssen, 2017; Ølnes, 2016).

Yet, there is limited empirical evidence of blockchain use, despite its huge potential (Batubara, Ubacht and Janssen, 2018). Reviewing the literature, it can be found that very few studies have investigated the key forces that drive blockchain adoption (e. g., Khalil and Ahmed, 2024; Aich et al., 2021) or restraining forces of the blockchain adoption process (e.g., Kouhizadeh, Saberi, and Sarkis, 2021). However, no studies have addressed the driving forces and restraining blocks of blockchain technology adoption decisions along with empirical evidence yet, which is crucial in understanding the technology adoption decision and readiness for technology implementation. Thus, this research initiates to identify these factors and the research objective is to explore the factors propelling and hindering blockchain adoption decisions in healthcare.

This study utilised Lewin's Force field analysis (1951) and Tornatzky and Fleischer's (1990) TOE (technology, organization, and environment) framework as the theoretical lens to identify these factors. In addition, it critically examined the literature on organisational change due to technology implementation, and factors influencing technology adoption decisions and, thus, attempted to develop knowledge that will facilitate the successful implementation of blockchain technology in the health sector.

From the theoretical perspective, this study will fill the gap in the existing literature by identifying the driving forces and restraining blocks of blockchain adoption decisions. From a practical perspective, this study's findings will facilitate blockchain implementation in the healthcare sector.

2. Literature review

This section illustrates blockchain technology, the theoretical underpinning of the research, related works in existing literature, and the conceptual framework of the research.

2.1 Blockchain technology and its potential in healthcare

The blockchain is a distributed database or public ledger that maintains permanent and verifiable records of all digital transactions of participating parties (Gatteschi et al., 2018; Zheng et al., 2017; Crosby et al., 2016). It comprises several core technologies, such as digital signatures, cryptography, consensus algorithms, distributed computing, and peer-to-peer networks (Monrat, Schelén and Andersson, 2019; Niranjanamurthy, Nithya and Jagannatha, 2019). As the chain of blocks grows with each new transaction, asymmetric cryptography, and distributed consensus algorithms have been used to maintain security and reliability (Zheng et al., 2017). As a result, each transaction of this public ledger is verified by the consensus of most participants and cannot be deleted (Gatteschi et al., 2018; Crosby et al., 2016). It is also the most secure distributed transactional database (Beck et al., 2017). In recent times, blockchain technology has emerged as a reliable and potential solution for data privacy, security, and integrity issues in healthcare (Yaeger et al., 2019; Rawal, 2018; Engelhardt, 2017; Lee and Pilkington, 2017; Yli-Huumo et al., 2016).

In the healthcare sector, keeping a permanent health record is essential because historical data not only provides information about the patient but is also significant in epidemic analysis (De Aguiar et al., 2020). Therefore, these data are of great value to physicians as well as researchers (Wechsler et al., 2003); however, patients' medical data must be considered confidential because it refers to the patients' personal data (De Aguiar et al., 2020). In the digital age, smart devices and mobile health have become popular and make ease of data sharing; however, this also imposes a high risk of malicious attacks and compromise of personal data (McGhin et al., 2019). Some authors considered the emergence of blockchain technology as a possible solution to manage this reliability and safety issue in data storing and data sharing in the healthcare sector (Dubovitskaya et al., 2017; Xia et al., 2017).

Blockchain technology has been explored in several healthcare applications, like data management, storage, and security in the Internet of medical things, and these applications bring improvements in the quality of experience of most stakeholders including patients, doctors, diagnostic companies, pharmaceutical companies, and insurance companies (Khezr et al., 2019). Ekblaw and Azaria (2016) addressed that the immutable nature of records in blockchain improves the quality of data auditing and makes it transparent for all. Besides, easy and fair insurance claims will reduce the costs of medical care by coordinating claims with treatment rendered (Ekblaw and Azaria, 2016).

Blockchain technology offers several benefits, including disintermediation, decentralization of data, data security, and reduction of necessary trust between business partners (Rückeshäuser, 2017; Avital et al., 2016; Weber et al., 2016). It will enable a transparent and secured data storage and distribution system in healthcare, increase the quality of healthcare services, and reduce its cost (Khezr et al., 2019). The positive outcomes of blockchain applications in healthcare (for instance, optimized business processes, improved patient service, better data management, enhanced compliance, and lower cost) will positively affect the experiences of most stakeholders, including patients, hospitals, clinics, other caregivers, researchers, pharmaceutical companies and insurance companies (Khezr et al., 2019; Mackey et al., 2019; Zhang et al., 2018).

Though security is the main strength of blockchain technology, still many scholars point to it as a challenge, such as cybersecurity or threats (Angraal, Krumholz and Schulz, 2017; Moura and Gomes, 2017). Besides, the insufficient knowledge and lack of understanding of blockchain technology have posed challenges to its widespread applications (White, 2017).

In addition, Lander and Cooper (2017) mentioned that digital accessibility is another challenge of blockchain. There is a significant digital access inequity between developed and developing countries (Peña-López, 2016). For instance, lack of internet infrastructure, technical education, technologically skilled people, and cultural and language barriers (Zjednoczonych, 2014) might create a challenge in blockchain implementation in developing countries.

Also, organizations need to transform to avail the benefits of blockchain technology implementation (Ahram et al., 2017; Ølnes et al., 2017). Thus, unfavourable reactions or resistance toward organizational change within the organization is another challenge of blockchain implementation because it is still a relatively new technology (Ølnes and Jansen, 2017; Ølnes et al., 2017; Sullivan and Burger, 2017; Ølnes, 2016; Sharples and Domingue, 2016).

Blockchain applications in healthcare can be categorized into three groups: data management, supply chain applications, and interest in medical things, such as data security, artificial intelligence, etc. (Khezzar et al., 2019). This study focuses on the utilization of blockchain in data management, particularly the implementation of blockchain-based EHR systems in healthcare.

2.2 Lewin's Force Field Theory

Kurt Lewin's (1951) force field analysis is considered a seminal work in organizational development, particularly regarding user resistance to change. Lewin proposed that social systems naturally resist change and strive to maintain a state of equilibrium. This equilibrium is achieved through a balance between forces driving change and those restraining it. Consequently, the success of change initiatives hinges on an organization's ability to disrupt this equilibrium by managing these opposing forces (Laumer & Eckhardt, 2012).

Lewin identified two key forces influencing the change process within an environment: driving and restraining forces. Driving forces exert a positive influence, pushing for change to occur. Conversely, restraining forces act to maintain the status quo and impede change. These forces can be observed within both the internal and external environments of organizations (Lewin, 1947).

Driving forces can be triggered by external pressures necessitating change, internal issues with existing systems, or simply a desire for improvement. Conversely, restraining forces create barriers that hinder change. Examples of restraining forces include fear of project failure, negative experiences with past change initiatives, or a reluctance to relinquish the current state of comfort. For successful change to occur, the driving forces must be strengthened to outweigh the restraining forces, which can be weakened or eliminated altogether (Lewin, 1951).

Lewin's three-stage model of change (unfreezing, change, refreezing) reflects this dynamic. The unfreezing stage involves identifying the driving and restraining forces to guide the organization toward the desired change (Lewin, 1951). The second stage focuses on implementing the desired changes by selecting the appropriate leadership style. Finally, the refreezing stage establishes stability once the changes have been implemented (Lewin, 1947;

Al-Haddad and Kotnour, 2015). This final stage is crucial for ensuring the change is sustained and persists over time.

2.3 The Technology-Organization-Environment (TOE) Framework

Developed by Tornatzky and Fleischer (1990), the Technology-Organization-Environment (TOE) framework offers a multi-perspective lens to examine the adoption of technological innovations within organizations (Piaralal et al., 2015; Tornatzky, Fleischer and Chakrabarti, 1990). Its core function lies in predicting and explaining the likelihood of an organization adopting a specific innovation (Awa and Ojiabo, 2016).

The framework posits three key constructs that influence organizational innovation adoption: technological factors, organizational factors, and environmental factors (Tornatzky et al., 1990). By analyzing these factors, the TOE framework aims to identify both the incentives and barriers that organizations face when considering the adoption of new technologies (Clohessy and Acton, 2019).

The technological dimension focuses on the inherent attributes and potential benefits of the innovative technology itself (Tornatzky et al., 1990). It encompasses factors such as complexity, relative advantage, security, privacy, and compatibility, all of which can influence the adoption process of both existing and new systems (Rogers, 2003). Organizational dimension pertains to the internal characteristics of the organization, such as employee IT skills and experience, organizational innovativeness, management support, organizational size, and overall readiness for change are all considered within this context (Tornatzky et al., 1990). The environmental dimension focuses on the external business environment surrounding the organization. It includes factors such as competitors, business partners, customer base, regulatory landscape, and broader industry dynamics (Tornatzky et al., 1990). By examining these three interrelated constructs, the TOE framework provides a valuable tool for understanding the complex dynamics that technology adoption decisions.

2.4 Related works

Inherent to its design, blockchain technology offers a multitude of advantages, these include enhanced transparency, improved privacy protections, guaranteed data integrity, facilitated data sharing, cost reduction, and increased efficiency (Alzahrani, Daim and Choo, 2022). It fosters industry collaboration and facilitates the development of novel business models by establishing interoperability and operational efficiency across the industry (Leventhal, 2017).

This technology empowers patients with greater ownership and secure transfer of their medical records (Rehman et al., 2022). The immutability of transactions on the blockchain ensures data integrity (Umar et al., 2022; Almeshal and Alhogail, 2021). Traceability, another key advantage, allows healthcare systems to track health records, detect medical errors and incorrect prescriptions, and potentially reduce the cost of counterfeit drugs (Khan et al., 2022; Golpîra, Khan and Safaeipour, 2021; Katuwal et al., 2018; Wong, Yee and Nøhr, 2018). Furthermore, blockchain minimizes unauthorized access to personal health information by restricting unauthorized users from deriving it (Dagher et al., 2018). Encryption of patient data on the network further enhances data security (Ivan, 2016).

Beyond data security, blockchain fosters collaboration between different healthcare organizations, facilitating medical research (Dagher et al., 2018). The smart contract

functionality embedded within the blockchain can automate many traditionally labour-intensive tasks, eliminating human error and judgment-based inconsistencies (Khan et al., 2022; Umar et al., 2022; Khan et al., 2021; Sharma et al., 2021). This not only improves efficiency but also reduces costs associated with human capital for actions like billing and record creation (Sharma et al., 2021; Wong et al., 2018).

Current healthcare systems face significant challenges, including administrative and transactional cost burdens, difficulties with health data sharing, and data security vulnerabilities. Existing literature on blockchain technology demonstrates its potential to address several shortcomings of the current healthcare system. The automation of actions, facilitated by blockchain technology and smart contract functionality, holds the potential to significantly reduce administrative costs within the healthcare system (Stagnaro, 2017). This automation streamlines back-office data entry and maintenance processes, demonstrably improving both data accuracy and security (Stagnaro, 2017). Additionally, the inherent transparency of blockchain eliminates the need for intermediaries, thereby reducing administrative burdens and processing time for both healthcare providers and payers (Rabah, 2017).

While blockchain technology offers significant advantages to the healthcare industry, its widespread adoption necessitates addressing various challenges and considerations. These challenges encompass technological limitations, governance structures, organizational resources, and broader societal concerns that could impede its transformative potential within the healthcare sector (Wong et al., 2018; Iansiti and Lakhani, 2017). Hogan's research highlights the specific difficulties associated with blockchain implementation, including immature technology, a talent gap, regulatory hurdles, lack of leadership buy-in, unclear return on investment (ROI), and a dearth of compelling business cases (Hogan et al., 2016).

The inherent tension between privacy and transparency is a key challenge associated with blockchain technology, due to its distributed ledger nature. However, researchers also argued that blockchain can achieve a superior level of privacy compared to centralized systems (Wüst and Gervais, 2018). Furthermore, a lack of clarity regarding stakeholder motivations for blockchain implementation can hinder adoption (Ivan, 2016). Another significant barrier is the absence of robust financial incentives for entities to participate in and build large network blockchain solutions (Pirtle and Ehrenfeld, 2018). The scarcity of successful blockchain implementations and use cases within healthcare creates cost uncertainties. These uncertainties encompass the costs of production deployment, operation, data sharing, regulatory compliance, and ongoing maintenance (Mamun, 2022; Clohessy et al., 2020). Additionally, the scalability of blockchain technology presents a substantial concern for its widespread adoption in healthcare (Roehrs, Da Costa and da Rosa Righi, 2017).

The uncertainty surrounding regulatory frameworks for blockchain applications represents another significant challenge (Katuwal et al., 2018). Healthcare organizations undertaking blockchain initiatives must remain vigilant and adaptable in response to evolving regulatory landscapes (Hogan et al., 2016).

The nascent stage of development for blockchain technology, coupled with a limited number of established use cases within the healthcare sector, presents a significant barrier to adoption by many healthcare organizations (Alzahrani et al., 2022). Furthermore, a lack of standardization across blockchain products and electronic health record (EHR) systems poses another key challenge. Inconsistent data standards within EHR systems significantly hinder data exchange capabilities (Orcutt, 2017). Similarly, the lack of standardized protocols among

blockchain vendors and clients leads to software incompatibility (Kharif, 2018). While literature suggests that standardization may pose less difficulty in smaller-scale implementations compared to large-scale projects (Ølne et al., 2017), it remains a significant hurdle for broader adoption.

Researchers have extensively investigated the challenges and considerations surrounding blockchain adoption. Clohessy, Acton, and Rogers (2019) employed innovation theory to explore factors influencing blockchain technology adoption through a technological, organizational, and environmental lens. Their findings indicate that technological considerations encompass complexity, data security, and the maturity of the technology itself. On the organizational front, factors such as organizational readiness, top management support, and organizational size play a significant role. Finally, environmental considerations include the regulatory environment, market dynamics, and the level of government support.

Focusing specifically on the healthcare context, McGhin et al. (2019) identified several limitations and challenges associated with blockchain implementation. These limitations include the lack of standardization, the potential for privacy leakage due to decentralized storage, key management issues, and scalability concerns. Furthermore, establishing a successful blockchain ecosystem requires collaborative efforts among various stakeholders. These efforts involve defining use cases, setting standards, developing necessary infrastructure and applications, and ensuring the smooth operation of the blockchain network.

Batubara et al. (2018) conducted a systematic literature review to explore the challenges impacting blockchain adoption within e-government initiatives. Their findings highlight security concerns, scalability limitations, user acceptance issues, and the lack of a robust legal and regulatory framework as key challenges.

Blockchain technology is still in its early stage of implementation, particularly in the healthcare sector; therefore, its adoption in healthcare will certainly be challenging (Siyal et al., 2019). A review of existing literature demonstrates that there is some research investigating the potential benefits of blockchain in healthcare, how these unique features solve the limitations of existing health systems, and its potential challenges. Though numerous studies also pointed out that due to the unique features of blockchain technology, stakeholders' engagement is crucial for its successful implementation, there are limited studies investigating the factors that influence blockchain adoption decisions from stakeholders' point of view. It offers evidence that a comprehensive and empirical investigation is necessary, encompassing both a thorough analysis of the driving forces and restraining blocks of blockchain adoption decisions in the healthcare sector from the stakeholders' perspectives. Thus, this research will fill up the existing knowledge gap and pave the way for a more informed and strategic adoption of blockchain technology within the healthcare sector.

2.5 Theoretical lens and conceptual framework of this research

Technology implementation typically occurs in three distinct stages: pre-implementation, implementation, and post-implementation (Narayanamurthy & Gurusamy, 2016). Each stage involves various activities and preparations critical for success. Scholars have emphasized the importance of organizational readiness as a cornerstone of successful technology adoption, with estimates suggesting that nearly half of large-scale change initiatives fail due to inadequate readiness (Armenakis and Bedeian, 1999; Kotter, 1996). Therefore, conducting a readiness assessment during the pre-implementation stage is crucial to identify factors that can positively or negatively influence the technology adoption decision.

This research adopts Lewin's force field theory (Lewin, 1951) as its primary framework due to its suitability for analyzing the dynamics of change. Lewin's theory posits that social systems maintain a state of equilibrium through a balance between driving and restraining forces. The success of change initiatives hinges on the ability to disrupt this equilibrium by strengthening driving forces and weakening restraining forces (Lewin, 1951). The "unfreezing" stage within Lewin's three-stage change process (unfreezing, change, refreezing) further emphasizes the importance of addressing these forces early on (Lewin, 1951).

While other change models, such as those proposed by Kotter (1999) and Judson (1991), focus primarily on organizational or management perspectives, Lewin's model offers a broader scope. As highlighted by Burnes (2004), Lewin's theory encompasses not only organizational change but also considers the dynamics of change within groups and society as a whole. This broader applicability aligns well with the present research, which focuses on change within the healthcare sector.

Several other prominent theories have been used to investigate user resistance to technology adoption, including the status quo bias (SQB) theory (Samuelson & Zeckhauser, 1988), the expectation confirmation model (ECM) (Bhattacharjee, 2001), the innovation diffusion theory (IDT) (Rogers, 1962), Cenfetelli's (2004) dual-factor theory, the technology acceptance model (TAM) (Davis et al., 1989), and the unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003). These models are particularly valuable in contexts where technology has already been implemented and user experiences are available. However, Lewin's theory is particularly well-suited for the pre-implementation stage, where the focus is on understanding and potentially mitigating factors that may influence adoption before the technology is even deployed.

Furthermore, this research incorporates the Technology-Organization-Environment (TOE) framework to investigate the driving and restraining forces influencing technology adoption. The TOE framework's multidimensional approach, encompassing technological, organizational, and environmental factors, aligns well with the broad research context like the healthcare sector (Tornatzky et al., 1990).

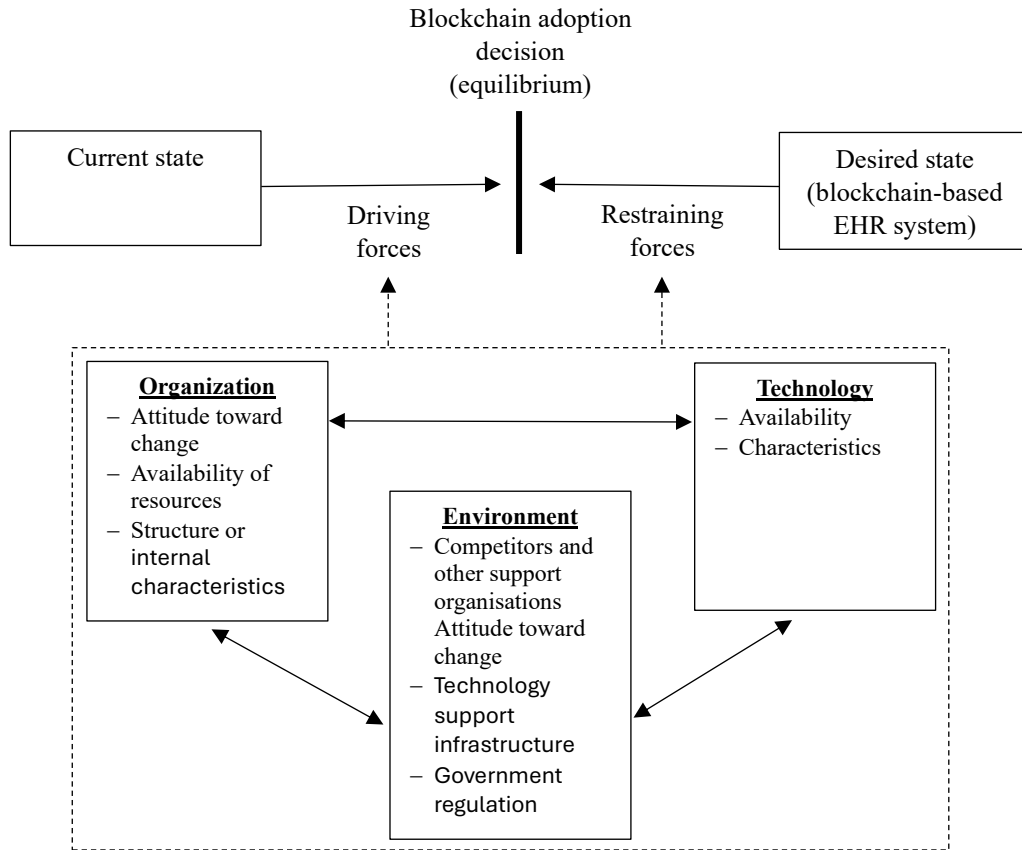


Figure 1: Conceptual framework (based on Lewin's force field theory and TOE framework)

3. Methodology

The exploratory research was considered appropriate as it is helpful to illustrate how a phenomenon is established and to explore a little-known phenomenon (Polit and Beck, 2008) like blockchain in healthcare. This research found the healthcare sector in Bangladesh appropriate for addressing the research question as the Government of Bangladesh (GoB) designed a 'National Blockchain Strategy' in March 2020 with a visionary idea: blockchain-enabled Bangladesh by 2030 (Ferdous et al., 2020). The GoB aims to implement blockchain technology for privacy-preserving collection, storage, and retrieval of health data in the healthcare sector. In Bangladesh, when patients undertake any medical treatment and diagnosis, they keep medical records to themselves. Therefore, there is no scope to preserve, store, and retrieve such information for further consultation. With the desire to solve this problem, this strategy set a vision to develop a blockchain-based central database that will store and retrieve medical data in a privacy-friendly way (Ferdous et al., 2020). However, Bangladesh is currently in the pre-implementation or planning stage of blockchain technology in healthcare. Therefore, the national blockchain strategy of Bangladesh emphasises academic research and, thus, creates awareness and encourages the related stakeholders to participate in the implementation process.

3.1 Data collection

Data has been collected from both primary and secondary sources. The purpose of using multiple data sources in qualitative research is to establish a comprehensive understanding of

the research phenomena or data source triangulation (Patton, 1999) to enhance the reliability of the study (Stavros and Westberg, 2009).

The secondary data were collected from the official documents published in international and regional organisations. This study aimed to investigate the grey literature (e.g., conference proceedings, project reports, issue papers, white papers, briefing notes) to validate the theoretical underpinning and supplement the primary data collected from interviews. Therefore, rather than utilising any established database, such as PubMed or Scopus, international and regional organisations' websites were included in the preliminary selection of the documents.

With the above basic concepts in mind, a search strategy in the public domain was developed to identify official reports. The search strategy was implemented using the official websites and report databases from a list of international (worldwide), regional (Asia), and sub-regional (South, East, and Southeast Asia) organisations. The search was done between August and September 2023 and included reports published from January 2016 to September 2023. The search process started with identifying the sections on each website called documents, libraries, reports, or publications. The broader database was selected if there were more than one of these sections, for instance, the UN's website. Afterward, critical terms related to the research objectives were applied to select the documents: blockchain, blockchain technology, and blockchain in healthcare.

Thus, 141 reports were identified in total. Initially, 21 documents were selected for analysis; however, during the final reading, five documents were excluded due to their irrelevancy to the research objectives. Table 1 illustrates the exclusion criteria of the documents.

Table1: Document exclusion criteria

Exclusion criteria	Number of documents
Publications or articles	4
Not official reports	3
Focus on sectors other than healthcare	51
Focus on technical aspects of blockchain	28
Country specific reports	15
Minimum or no relevancy to the research objectives	21
Documents in another language	3
Total	125

Finally, the analysis included 16 documents published by seven organisations relevant to the research problem and objectives.

The Directed Qualitative Content Analysis (DQICA) approach was applied to analyse the secondary data. This is a deductive approach to qualitative content analysis consisting of three phases and eight steps (see Figure 2).

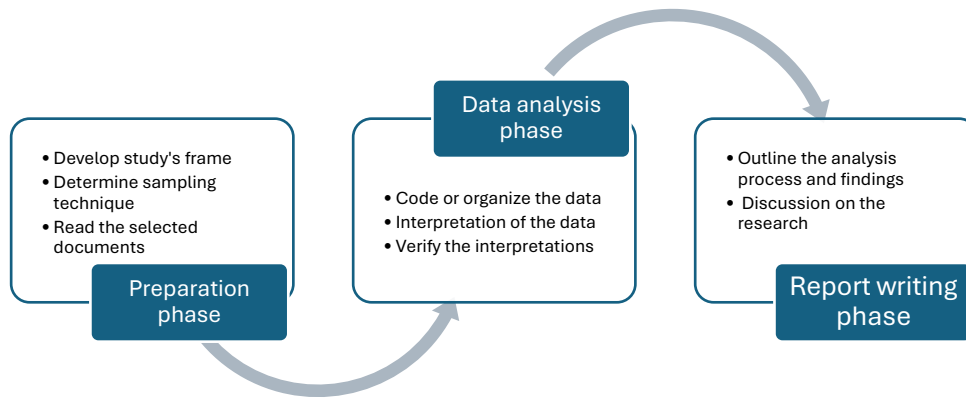


Figure 2: DQICA's Phases and Steps (Kibiswa, 2019)

In addition, structured in-depth interviews with relevant stakeholders were done to collect primary data. The combination of purposive sampling and snowball sampling was applied in this research. Recruiting samples for interviewing was a real challenge due to the unfamiliarity of blockchain technology in Bangladesh. From January 2023 to August 2023, twelve interviews were conducted, including interviews with four technology experts, two government policy advisers, three doctors, and three administrative officers of hospitals. The semi-structured interview guide covered a series of questions to explore respondents' perceptions of the current healthcare sector, its data management systems, blockchain technology, potentials of blockchain in healthcare, and factors influencing their blockchain adoption decision. Braun and Clarke's (2022) six phases of reflexive thematic analysis were followed to analyse the primary data.

4. Findings of the study

This section presents the findings of a qualitative study based on document analysis and primary data collected through twelve interviews with Bangladeshi respondents. Table 2 summarises the factors propelling and hindering the blockchain adoption decision based on the key findings of the analysis.

Table 2: The driving and restraining forces toward the blockchain technology adoption decision

Driving forces	From empirical analysis	From document analysis	Restraining forces	From empirical analysis	From document analysis
Limitations of the existing system			Technical challenges		
– No permanent health record	✓		– Hardware limitation	✓	
– Inefficient and delay in treatment	✓		– Software limitation	✓	
– Lack of credibility of test results	✓		– Ensuring data privacy		✓
– Lack of accountability of the health service providers	✓		– Lack of interoperability		✓
– Repeat test and high out of pocket expenditure	✓		– Lack of scalability	✓	✓
– No referral system	✓		– Insufficient digital accessibility	✓	✓
Unique features of blockchain			Non-technical challenges		
– Immutability	✓	✓	– Lack of technologically skilled people	✓	✓
– Decentralized system	✓	✓	– Corruption	✓	
– Consensus mechanism	✓	✓	– Rigidity or unwillingness to change	✓	✓
– Traceability	✓	✓	– Initial (establishment) cost	✓	✓
Perceived usefulness			– Regulatory uncertainty		✓
– Enhanced performance	✓	✓	– Infringement of law and legislation		✓
– Efficient and dynamic data sharing	✓	✓	– Lack of stakeholders' engagement		✓
– Patient-centric data management		✓			
– Improved medical intervention	✓	✓			
– Efficient response to medical emergencies	✓	✓			
– Disintermediation		✓			
– Improved transparency	✓	✓			
– Reduced corruption	✓	✓			
– Enhance public trust	✓	✓			
– Reduced operational cost	✓	✓			
Resource availability					
– Institutional capacity		✓			
– Stakeholders' knowledge and understanding		✓			
– Supportive policy environment		✓			
– Technological innovativeness		✓			
Viable uses					
• Successful use cases (visibility)		✓			
• Pilot projects (trialability)		✓			

4.1 Factors propelling blockchain adoption decision

Whereas analysis of the primary data revealed that the limitations of the existing healthcare system are the strongest driving force toward blockchain adoption decisions in Bangladesh, followed by the unique features of blockchain and its perceived usefulness. While a range of viewpoints emerged, a central theme across the interviews was the significant impact of limitations, such as no permanent health record system, lack of credibility and accountability of the health service providers, and no functional referral system, within the current healthcare system.

One respondent who is a doctor linked the absence of a permanent health record system to inefficiencies in treatment delivery as

“You cannot expect patients to remember every detail. So, how do I know about what kind of treatment he received last time and from where I need to start? What we do, based on his current condition, give him treatment, which is inefficient” (Respondent 7).

Similar concerns were echoed by two other doctors (Respondent 8 and 11), who both alluded to the difficulties encountered due to a lack of readily available past medical records. Respondent 11 emphasizes the obstacles faced in patient follow-up, while Respondent 8 highlights the potential for misdiagnosis in the absence of prior treatment information.

Interviews revealed a significant concern regarding the lack of credibility in test results provided by diagnostic centers in Bangladesh that necessitate repeat testing for patients. This has a multifaceted negative impact on the healthcare system, leading to increased costs, treatment delays, and unnecessary patient burden. One respondent highlighted the prevalence of conflicting test results and the difficulty in holding diagnostic centers accountable due to the absence of a central database as follows:

“In Bangladesh, it is a common thing that we usually get wrong test reports; the same test can have two different results in two diagnostic centres. Even if you challenge that they generate the wrong report, they will deny it, and it's difficult to prove as there is no central database. So, there is no credibility in the test reports. This is why doctors double-check test results, increasing the cost and hassle” (Respondent 1).

This lack of trust necessitates retesting by physicians, as confirmed by one doctor; he said that “another loss is time and money because we often need to ask him (patient) to do some repeat tests” (Respondent 7). Another doctor (Respondent 8) expands on this point, outlining how repeat testing increases overall healthcare expenditure and delays treatment initiation.

The respondents suggested that a blockchain-based EHR system would improve transparency and accountability by questioning the need for repeat tests.

“If there is a blockchain-based EHR that keeps all the records permanently, then once the patient does the test, the records will be in the system. Suppose he changes the doctor immediately, and the doctor asks him to test again. In that case, he can ask about the necessity of doing so, and doctors will be liable to justify or give a reason for repeated tests. Even diagnostic centres become liable for any wrong

results, which is very common in Bangladesh. So they will be more sincere,....”
(Respondent 9).

Another concern expressed related to the existing healthcare system was that there is “*no functional referral system*” in Bangladesh” (Respondent 4). Respondent 8 exemplifies this challenge as a doctor, highlighting the difficulties faced by specialists in providing timely diagnoses and treatment plans due to the lack of a centralized and accessible patient medical record system. The participants suggest that a decentralized system like blockchain-based EHR could offer a viable solution to this issue.

These findings suggest that the limitations of the existing healthcare sector significantly influence the public's receptiveness to adopt a permanent and distributed health record system such as blockchain. The data reveals that the inherent features of blockchain and its perceived usefulness in addressing current challenges inspire them to consider blockchain-based EHR systems in hospitals.

Technical literacy plays a role in understanding blockchain's potential impact. Technology experts highlighted the permanent nature of blockchain, ensuring data integrity and preventing unauthorized modifications (Respondent 1 and 9). This was seen as crucial for maintaining the confidentiality and accuracy of sensitive healthcare information because “*health-related data is very confidential and crucial, any tampering or altering false data can even cause the patient's death* (Respondent 9).”

The benefits of decentralised nature of blockchain have been highlighted in comparison to the conventional systems as, “*...in previous systems, transactions were centralised, whereas blockchain says it will be decentralised (copy of transactions to all nodes in the network)* (Respondent 1).”

Further, the consensus mechanism (the agreement process between network nodes) fosters transparency and trust within the record-keeping system by enabling transaction verification without relying on a central authority (Respondent 1 and 5). The ability to securely store sensitive health data was seen as essential for building trust within the healthcare sector. According to an interviewee,

“....people feel unsafe in consenting to keep their sensitive health data in any database due to the chance of data breaches. Blockchain-based electronic health record systems can be more trustworthy in this case” (Respondent 3).

The interviews highlighted the issue of fabricated COVID-19 test results and fraudulent health certificates. Blockchain-based EHR was suggested as a potential solution to these problems because blockchain could enhance public trust in healthcare providers by ensuring data immutability and traceability (Respondent 1, 4, and 8). Another interviewee who is a policy adviser of GoB mentioned these unique features of blockchain will enhance public trust in government as well. According to him,

“Blockchain-based EHR will ensure that the government can effectively utilise government funds for healthcare. It will ensure transparency in the healthcare sector as the transactions in blockchains are not alterable. So, even if anyone is corrupt, it is easy to trace. So, the government will automatically gain public trust”
(Respondent 12).

Likewise, respondents identified other potential benefits associated with blockchain technology, such as efficient emergency response and enhanced medical research. Respondent 2 suggested that a blockchain-based platform could offer "a single click" digital access to a patient's entire medical history, significantly improving response times; whereas respondent 9 highlighted the value of utilization of medical data in medical research, for instance, "analyze different critical diseases and find some remedies" using blockchain-stored records.

Overall, the perceived benefits of blockchain due to its distinguished attributes emerged as another key motivating factor. The recurring emphasis on blockchain's potential suggests a widely held belief that it can significantly improve healthcare delivery. Participants envisioned patients receiving more credible and efficient services, while doctors would be empowered to provide more effective treatment, and the government would be able to enhance national healthcare performance and gain public trust.

Though the respondents did not mention; however, there are two other factors found in the document analysis that influence positively the blockchain adoption decision. These are resource availability and use cases of blockchain implementation. The document analysis suggested that technical and non-technical resource availability is a crucial factor that fosters the technology adoption decision, such as institutional capacity, stakeholders' knowledge and understanding of blockchain, technological innovativeness, and policy environment. Furthermore, Any organisation may exhibit a positive drive to adopt blockchain technology when the technology is viable (Liang et al., 2021). Though the deployment of blockchain in healthcare at the national level is still rare, the analysis reported a couple of successful use cases of blockchain in healthcare, along with a few pilot projects and planning, and these could be another propelling factor of blockchain adoption decisions.

4.2 Factors delaying blockchain adoption decision

Interviews highlighted a significant disparity in hardware resources between public and private hospitals. Participants from private healthcare generally felt their institutions possessed adequate hardware, including computers, digital equipment, and portable devices. In contrast, public healthcare representatives portrayed a situation of hardware limitations. However, the challenges extend beyond hardware to software inefficiencies. Doctors encountered difficulties with simple tasks like finding appropriate medications or dosages within the online prescription system. This is also accepted by the private hospital's representatives. to ensure integration and smooth operation as follows. Respondent 6 mentioned that

"If the hospitals want to implement blockchain or EMR, it may ensure all the necessary hardware facilities, especially the private and large hospitals. But they will need more efficient software or customized software."

Limited network infrastructure, particularly in rural areas, poses a significant challenge to blockchain adoption. In addition, several participants pointed towards a lack of experience and expertise within the IT sector in delivering efficient health information systems. Respondent 6 cited issues with failed commitments, inability to meet desired functionalities, and project delays encountered while working with local software companies. Interestingly, he mentioned monopoly in the IT industry despite thin inefficiency and unprofessionalism as follows.

"....the software company we are working with provides 80% of hospital information system software to hospitals in the healthcare sector in Bangladesh. So, we have no better option than this"(Respondent 6).

Thus, the negative experience with software providers and their monopoly in the market hinder people's blockchain adoption decisions in the healthcare sector.

Moreover, respondents also listed the key non-technological factors hindering blockchain adoption in the Bangladeshi healthcare system, such as corruption, lack of skilled workforce, people's negative perceptions and unwillingness to change, and financial limitations. Interviews with participants revealed concerns surrounding corruption as a significant obstacle to blockchain adoption within the Bangladeshi healthcare system. Respondent 5 highlighted the pervasiveness of corruption in healthcare, citing the practice of selling government-supplied medicines to pharmacies instead of providing them to patients for free.

He further argued that individuals or groups profiting from such corrupt practices might actively resist the implementation of blockchain technology. Their vested interests could lead to a lack of cooperation and hinder the adoption process.

Also, respondent 7 expressed concerns regarding the skills and training gaps within the current healthcare workforce. He suggested that the existing staff might not possess the necessary technical skills or training to effectively utilize blockchain technology. He reported regarding this as *“the main problem is that they may be unwilling to accept it. The existing human resources will not be happy if we digitalise the system”* (Respondent 7). Another participant mentioned that as Bangladesh is in the nascent stages of implementing blockchain technology in healthcare, a general lack of familiarity and comfort with the technology is to be expected. This may lead to a reluctance to embrace the changes associated with adopting a new system (Respondent 1).

The interviews revealed financial limitations as another key barrier to blockchain adoption in the Bangladeshi healthcare system. While acknowledging financial limitations in some hospitals, respondent 10 who is an administrative officer of a hospital mentioned that hospitals might prioritize purchasing medical equipment over software solutions, reflecting their focus on immediate patient care needs. According to him, *“if they (hospitals) have a five-crore fund, they might consider buying medical equipment rather than investing in software”* (Respondent 10).

5. Discussion on findings

The analysis of the driving forces revealed that the perceived usefulness is comparatively the most potent force compared to the others. On the contrary, resource availability is the weak force to impact the blockchain adoption decision, particularly in developing countries like Bangladesh. The possible explanation for this result is the scarcity of the required resources, such as institutional capacity, supportive policy, etc. that strongly drive the intention to adopt blockchain. Though the positive impact of the viable use cases is mentioned in the literature, as blockchain implementation in the healthcare sector is still limited, it has minimal or no impact on adoption decisions. However, any successful cases are appreciable and might drive others to think about blockchain implementation.

The current study found that blockchain has overcome its initial hypes and is well recognised for its usefulness and unique features, like identity verification, smart contracts, dynamic and real-time data sharing, etc. These features promise performance enhancement in healthcare and control of corruption. In accordance with this result, previous studies demonstrated that blockchain enables the healthcare sector to be corruption intolerant (Pandey and Litoriya,

2020). However, the findings did not detect direct evidence of cost-effectiveness in developing and implementing blockchain. Showing consistency with the previous studies (Yaqoob et al., 2020; Gökalp et al., 2018), the results evidenced the expected reduction in operational and administrative costs from service providers' perspectives and in healthcare costs from patients' perspectives. Therefore, a possible explanation for this result might be that the initial cost of blockchain design and implementation is a kind of investment for the business. However, this differs from the study of Angraal et al. (2017), which confirmed that the cost-effectiveness of blockchain in healthcare has not been proven yet.

One of the compelling findings of this analysis is that developing countries still suffer from institutional capacity building. Institutional capacity refers to the availability of resources (human, technical, and financial) and structures that organisations require to perform toward a particular end (Bhagavan and Virgin, 2004). Comparison of the findings with those of other studies (Yaqoob et al., 2020; Kombe et al., 2019; Saif et al., 2022) confirms that due to the scarcity of both technical and non-technical resources, resource availability poses challenges rather than driving toward blockchain technology implementation.

The findings suggested very few viable use cases of blockchain implementation in healthcare. However, some of them listed a long list of blockchain exploration in the public services or other sectors, for example, World Bank's report on emerging technologies curation series, Issue # 1: Korea Blockchain Ecosystem, and ADGSOM (ASEAN Digital Senior Officials' Meeting) Project Completion Report. Though blockchain implementation in healthcare on a broad scale is still scarce, the implemented cases or pilot projects broadly support the findings of other studies (Zhang et al., 2018; Ismail & Materwala, 2020) in the area of performance enhancement due to blockchain implementation. These findings further indicate the trialability and observability of blockchain technology.

Subsequently, the analysis of the restraining forces revealed that insufficient technological infrastructure is the main technical concern regarding blockchain technology adoption decisions, and the technical and non-technical concerns are closely related. For this reason, it is critical to differentiate between technical and non-technical challenges, and researchers should be cautious when investigating the impact of technical attributes on blockchain adoption decisions. One striking finding is that some of the unique features of blockchain impose technical challenges and thus might delay the adoption decision; for instance, the immutable nature of the technology challenges the system's scalability. This also accords with previous studies which identified immutability as a valid concern for stakeholders towards blockchain technology implementation in healthcare (Abu-Elezz et al, 2020; Clohessy & Acton, 2019). Also, the distributed consensus mechanism removes the necessity of central control. However, it raises questions about individual data privacy, which leads to legal infringement of some fundamental rights of individual data privacy. This finding is in line with that of Fabiano (2017), who addressed the legal issues associated with data privacy issues of blockchain.

Furthermore, this study supported evidence from previous studies (Janssen et al., 2020; Yaqoob et al., 2020; Saif et al., 2022) that regulatory uncertainty and the lack of stakeholder engagement are the two most common non-technical restraining forces. A possible explanation for this finding might be that the technology is still in its early stages. However, respondents emphasized insufficient blockchain knowledge, unprofessionalism of software firms, unwillingness, and financial limitations as non-technical limitations. These are aligned with the work of Mamun (2022) who highlighted the shortage of blockchain-skilled people and the high cost of hiring them; Toufaily, Zalan, and Dhaou (2021) who emphasized creating blockchain awareness, educating people, and making the benefits of blockchain clear to improve people's

willingness to adopt it. The empirical findings revealed that in developing countries resource unavailability hinders technology adoption decisions strongly whereas resource availability push a little the adoption decision.

Theoretically, in this study, the first evaluated driving force was “perceived usefulness”, which is associated with the relative advantages of Rogers’s (1962) DOI (Diffusion of Innovation) theory. Relative advantages refer to the perceived usefulness of the innovation that will define the degree of betterment of the existing system (Lee, Hsien and Hsu, 2011). This is also aligned with one of the components of the Technology Acceptance Model (TAM) (Davis et al., 1989). Further, the attributes of technology itself and its perceived usefulness are consistent with the technological context of the TOE (Technology-Organization-Environment) framework (Tornatzky & Fleischer, 1990) that incorporates the innovation's attributes and availability. Lewin's three stages of the change process support the findings that the limitations of the existing system drive toward change (Lewin, 1947).

The following driving force, "resource availability," is derived from the compatibility of DOI theory and the organisational and environmental contexts of the TOE framework. Compatibility refers to the predictors of using an innovation (Carter & Bélanger, 2005). Similarly, the organisational context refers to the firm's structure and available resources that accelerate innovation adoption decisions. This study considered the environmental context to define this theme, such as industry features and policy environment (Chiu et al., 2017). The third driver, viable use cases, resembled the trialability and observability mentioned in Rogers's DOI theory, which positively influenced innovation adoption decisions.

In addition, the technical challenges paralleled the DOI theory and technology dimension of the TOE framework as it reflected the complexity of the technology and lack of technologically skilled human resources, slow Internet, insufficient facilities for technical education and training, etc. Finally, the non-technical challenges reflected the organisational and environmental contexts of the TOE framework as it covers the regulatory environment of blockchain and the non-technical resource structure of the organisations or healthcare sector.

6. Conclusion

This study was carried out to explore the factors that drive and restrain the blockchain adoption decision in the healthcare sector from the stakeholders’ perspectives. A document analysis and empirical research have been conducted in the context of Bangladeshi healthcare. The final remark of the study is that the driving and restraining forces of blockchain adoption decisions are context-specific, for instance, many forces found in the documents were not mentioned by the respondents whereas they emphasized several new forces. Further, one study limitation is the small sample size. Future research can be done following the same approach and theoretical lenses with a large and diverse sample. Also, the forces influencing blockchain adoption decisions could be weighted and quantified for a comprehensive understanding of their impact on future research. Theoretically, the findings of this study will supplement the analysis of the blockchain readiness studies in healthcare as it bridged the knowledge gap and distinguished the prevailing driving and restraining forces that influence the adoption decision of the stakeholders. Empirically, this knowledge will facilitate the efficient implementation of blockchain technology in the healthcare sector, particularly in developing countries.

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