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Blockchain adoption in Healthcare: Models, Challenges, and Future Work

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ABSTRACT

The utilization of blockchain technology (BT) has arisen as a viable remedy for tackling crucial challenges in financial system (bitcoin) and the healthcare sector, including data security, interoperability, and transparency. The integration of BT in the healthcare industry has significant promise, but it is a complex process that is impacted by several variables. This systematic review seeks to provide a thorough comprehension of the models, obstacles, and forthcoming research pertaining to the use of BT in the healthcare sector. The paper examines the fundamental ideas and models that are crucial in comprehending the implementation of BT in the healthcare sector. The theories encompassed in this list are the Technology Acceptance Model (TAM), Innovation Diffusion Theory, Trust and Transparency Theories. These theories together provide a systematic framework for evaluating the process of adoption. The systematic review results provide an overview of the present state of blockchain implementation in the healthcare sector. The challenges that have been highlighted include obstacles related to regulations, difficulties in achieving interoperability, concerns over data privacy, and the need for a strong and reliable infrastructure. Furthermore, the advantages of using BT, including heightened data protection and increased healthcare services.

1. Introduction

The emergence of blockchain technology (BT) has quickly become a powerful force with the potential to disrupt several industries, including the healthcare business [1]. Amidst the many issues faced by healthcare businesses, including protecting patient data, assuring data compatibility, preserving patient confidentiality, and enhancing the clarity of medical records, blockchain emerges as a pioneering solution [2, 3]. The integration of BT in the healthcare sector has been steadily increasing in recent years, providing a fundamental change in how healthcare organizations handle, exchange, and safeguard patient data [4]. Moreover, it offers an innovative method for optimizing administrative procedures and minimizing inefficiencies. Blockchain's fundamental advantages, such as

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decentralization, transparency, and tamper-resistance, make it a potent instrument for tackling the intricacies of healthcare data administration [5]. Despite the growing interest in using BT in healthcare, there is still a lack of knowledge on the theoretical models and factors that may effectively explain this acceptance [6, 7]. The healthcare sector is naturally complex, including a wide range of participants, confidential patient information, and strict regulatory obligations [8]. Currently, the healthcare industry is at the forefront of a technological revolution, with BT providing cutting-edge solutions [9]. Nevertheless, there is still a need to develop a strong and complete theoretical framework that can fully explain the use of BT in the healthcare industry [10]. Possible models for studying blockchain acceptance in healthcare include Technology Acceptance Models (TAM), Innovation Diffusion Theory (DOI), Trust and Transparency Theories, or other specific frameworks that provide insights into the intricacies of this process [11, 12, 13]. The adoption of BT in the healthcare industry is driven by several important variables [14]. These variables may include aspects of the technology itself, such as its capacity to scale, interact with other systems, and ensure the security of data [15]. Moreover, organizational factors such as the dedication of leadership, allocation of resources, and preparedness of the institution, have a crucial impact [16]. The importance of patient-related characteristics, data governance, and regulatory compliance is equal [4]. However, it is still not known what factors that can contribute to the adoption of BT [17]. The use of BT in the healthcare sector is accompanied by several obstacles [18]. These concerns may include data privacy, implementation costs, opposition to change, and interoperability challenges [2]. Conversely, BT may have significant advantages, such as enhanced data protection, visibility, and data availability [19, 20]. The study adds to the dynamic field of healthcare by conducting a thorough evaluation of the integration of BT and its possible effects. The report recognizes blockchain as an innovative option to address the urgent difficulties encountered by healthcare firms, such as data security, compatibility, confidentiality, and administrative inefficiencies. The study intends to address the lack of information about theoretical models and variables that influence the adoption of BT in the healthcare sector by conducting a thorough analysis of available literature. This text delves into the intricate interaction of technical, organizational, and regulatory factors, providing insight into the factors that encourage or hinder the adoption of BT. This thorough study aims to provide significant insights that help accelerate the transition of healthcare data management, boost security, and improve patient treatment. The purpose of the results is to provide information for future research and decision-making in the healthcare business, with the goal of creating a more efficient and secure healthcare system. The advent of BT has emerged as a forceful force capable of causing significant disruptions in several sectors, most notably the healthcare industry. The healthcare sector encounters several obstacles, including safeguarding patient data, maintaining data interoperability, upholding patient confidentiality, and enhancing the comprehensibility of medical records. Blockchain technology is positioned as an innovative approach to tackle these problems, providing decentralization, transparency, and tamper-resistance as core benefits.This research aims to conduct a systematic evaluation of the current literature in order to provide a thorough analysis of the obstacles and advantages related to the use of BT in the healthcare sector. By doing this, it can expedite the use of BT, possibly transforming the healthcare sector in terms of data administration, security, and patient treatment. It also evaluates the corresponding potential and obstacles. Through an analysis of different applications and upcoming patterns, the objective is to provide a comprehensive understanding of the possible advantages and drawbacks associated with the use of BT in healthcare environments. Therefore, it is crucial to investigate the theories, factors, obstacles, and advantages that form the foundation of using BT in the healthcare industry. The next section discusses the research methodology as well as the literature review, findings, discussion, and conclusion.

2. Research Methodology

This study represents a thorough systematic review, a precise and comprehensive analysis of numerous scholarly articles published in specific databases. The main goal is to clarify the different models that impact the adoption of BT in the healthcare field. In order to achieve this objective, a methodical approach is employed, enabling the organized identification, evaluation, and integration of relevant research. The process involve the article selection which involves the careful selection of articles. A comprehensive selection of pertinent literature is obtained by utilizing various reputable databases. Through the use of targeted terms like 'blockchain,' 'healthcare,' 'blockchain adoption,' and

related variations, the search parameters are precisely delineated. It is crucial to include a wide range of keywords to effectively cover different aspects of the adoption of BT in healthcare. By compiling a comprehensive cross-section of the existing literature, a thorough analysis is conducted.

The process also involves filtering for relevance. During this preliminary phase, a substantial collection of articles is generated. Nevertheless, it is important to note that not all articles that are retrieved will directly align with the research objectives. A thorough filtration process is conducted to extract the most relevant literature. In this process, each article is carefully evaluated and its content is assessed in relation to the study's focus. Ensuring that the review includes studies that truly contribute to the understanding of the subject matter is a crucial step. Reviewing the chosen articles, a thorough synthesis of the literature is carried out. This synthesis involves a thorough investigation and analysis of the chosen studies. The objective is to analyse the significant themes, theories, models, variables, challenges, and benefits that are collectively presented in the literature. This systematic review aims to consolidate, assess, and integrate the extensive information found in the chosen literature. The systematic methodology, supported by clearly defined search strategies and stringent relevance criteria, guarantees that the ultimate collection of literature examined is both comprehensive and inclusive of the most significant works in the discipline. Figure 1 shows the process of selecting the articles.

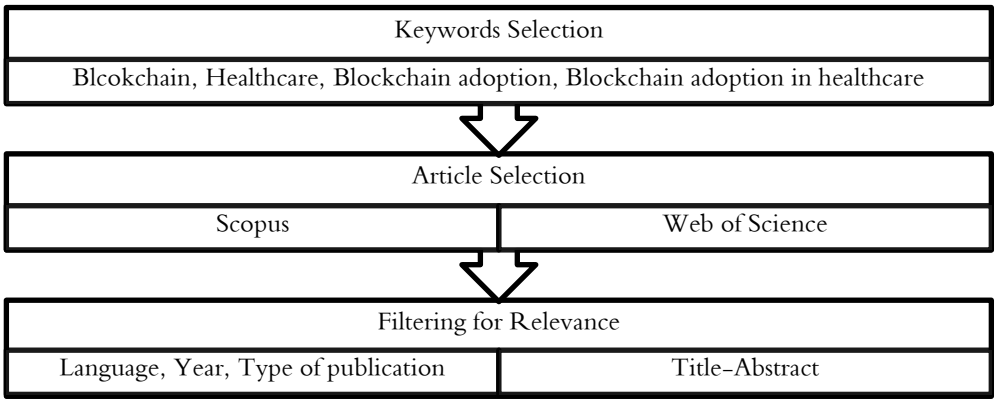

Fig 1: Process of Selecting Articles

3. Literature Review

This The adoption of BT in the healthcare industry is a multifaceted undertaking that is shaped by a range of factors, such as technological advancements, organizational considerations, and human factors. To gain a deeper understanding and effectively navigate this complex terrain, numerous significant theories and models have been formulated to offer a systematic framework for evaluating and explaining the process of adoption. These theories provide valuable insights into the dynamics of BT adoption for stakeholders in the healthcare industry, such as researchers, healthcare professionals, and policymakers. In the following sections, the important theories are discussed.

3.1. TAM

The TAM is a well-established theoretical framework that analyzes and clarifies the elements that impact the adoption of innovative technologies. TAM was introduced by [21], has since undergone expansion and customization to cater to many domains, such as the healthcare sector, in order to comprehend the adoption and use of technology by individuals or organizations. TAM and its extensions are useful tools for analyzing the variables that influence the readiness of healthcare professionals and organizations to use BT in the healthcare sector. In the initial TAM framework, variables such as perceived usefulness (PU), perceived ease of use (PEOU), behavioural intention (BI) and actual usage (AU) were proposed. PU in the context of blockchain in healthcare pertains to the users' perception of how the use of BT enhances their work processes and overall healthcare results. This includes enhancing the protection of data, the capacity of different systems to work together, and the effectiveness of healthcare transactions. PEOU pertains to consumers' perception of the level of simplicity in using BT.

Although blockchain is recognized for its intricate underlying technology, the perceived simplicity of usage in healthcare settings may be improved by user-friendly interfaces and training.

BI pertains to the user's deliberate decision and inclination to embrace and use BT. Healthcare personnel who perceive that using BT would have a beneficial effect on their job are more inclined to indicate their desire to use it. AU refers to the practical use of BT in the healthcare industry is a crucial indicator of the efficacy of TAM. The users' first-hand experience with the technology may either strengthen or alter their perception of its utility and simplicity of use. Figure 2 shows the conceptual model of TAM.

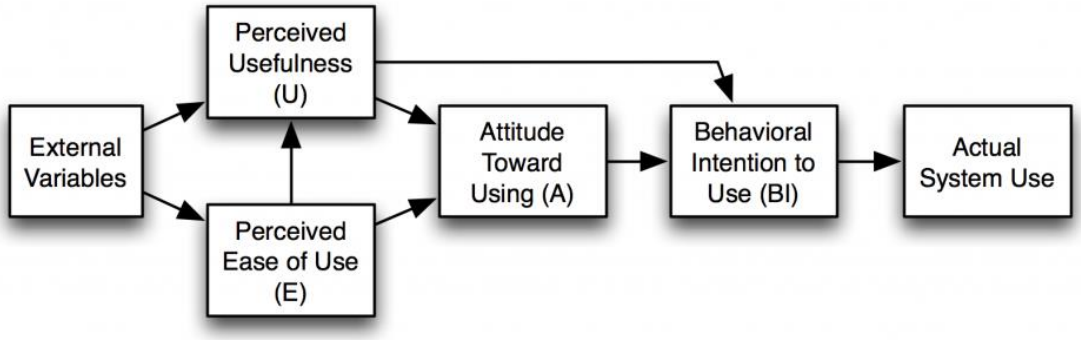

Fig 2: TAM model by [21]

TAM2 and TAM3 are expansions of the first TAM paradigm, created to provide a more thorough comprehension of technology adoption. When applied to the adoption of BT in healthcare, these variables aid in the analysis of the determinants that impact the acceptance of this technology by users and organizations. The introduction of TAM2 occurred in 2000 by [22]. The initial TAM is expanded by including additional variables that have the potential to impact the adoption of technology. The fundamental constituents of TAM2 encompass PU, PEOU as well as extrinsic motivation (EM) as an external determinant. TAM2 also includes job relevance (JR) which considers the degree to which individuals view a technology as applicable to their employment. Output Quality (OQ) assesses the perceived excellence of the product produced by using the technology. Figure 3 shows the TAM2.

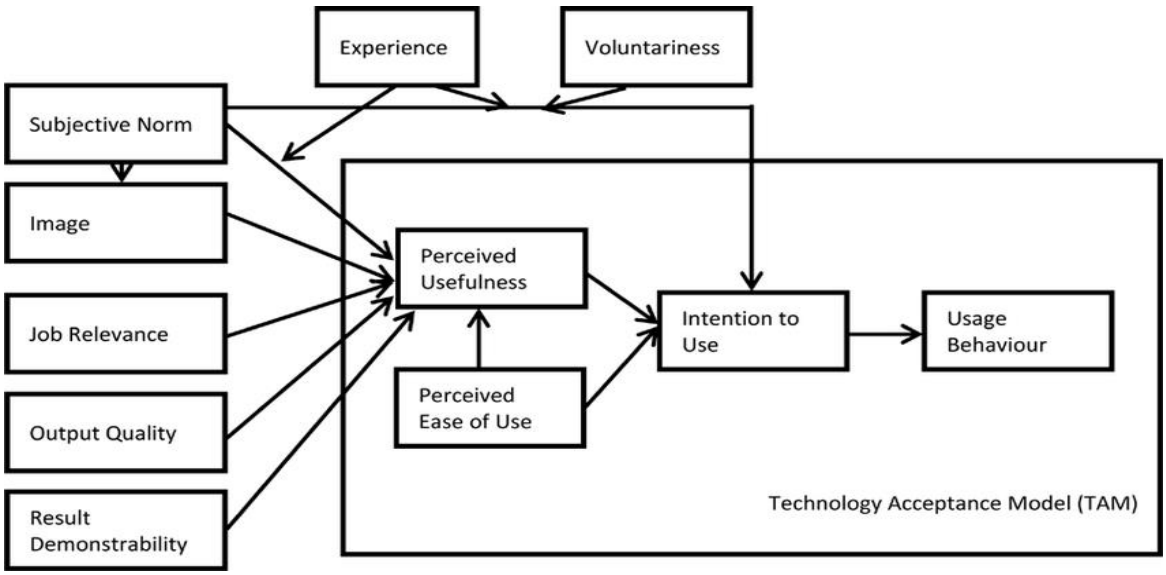

Fig 3: TAM2 [22]

The TAM3, proposed by [23] expands upon the TAM paradigm by integrating social and cognitive mechanisms. The components included the essential variables of TAM such as PEOU and PU and added

the Subjective Norm (SN) component which assesses the impact of social norms and peer pressure on the adoption of technology. In addition, other variables such as Cognitive Instrumental Processes (CIP) which refer to the cognitive processes used to assess the possible benefits and drawbacks of technology along with Affective Reactions (AR) which measures the emotional and subjective responses linked to the adoption of the technology. Figure 4 shows the model of TAM3.

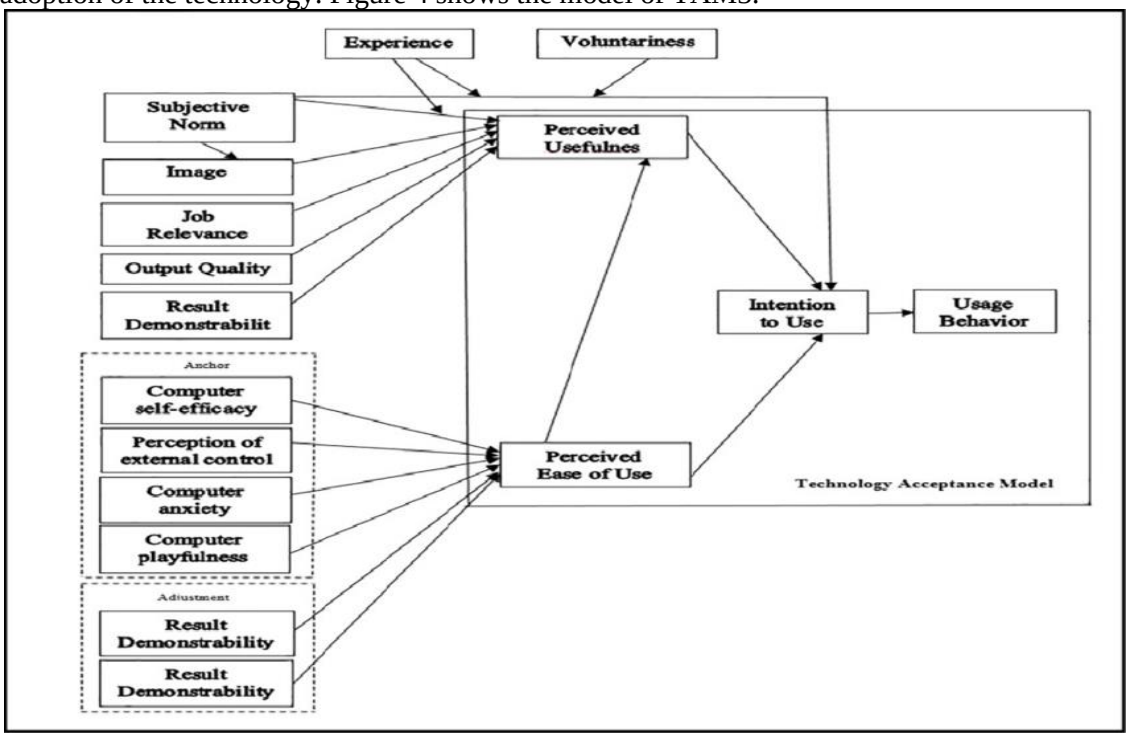

Fig 4: TAM3 [23]

In the context of the adoption of blockchain in healthcare, the TAM2 model effectively deals with the intricacies of healthcare environments by including factors like as extrinsic motivation, job relevance, and output quality. Within the realm of using BT in healthcare, it is crucial to comprehend the impact of external variables, such as government rules and incentives, as well as the perceived relevance of blockchain to healthcare roles. These elements significantly influence the decision-making process regarding the adoption of this technology. The TAM3 model has been extended to include social and cognitive factors. Within the realm of blockchain implementation in the healthcare sector, it is valuable to comprehend the impact of social factors, cognitive processes, and emotional responses on the choices made by users and organizations to use BT. This is especially pertinent in the healthcare industry, where choices are often swayed by colleagues and where emotional responses to the security and privacy of patient data may be key determinants.

3.2. DOI

DOI, proposed by [24] is a well proven sociological theory. This theory explains the mechanism by which innovations, including new technology, disseminate throughout a society or within a cohort of adopters. Rogers [24] delineated five phases that often govern the diffusion of an idea among adopters and these include acquisition of knowledge. During this phase, prospective adopters become aware of the innovation's existence and develop a comprehension of its functionality [25]. This phenomenon often occurs as a result of being exposed to several sources of information, such as news items, study results, or debates with peers. Within the realm of blockchain implementation in the healthcare sector, this phase would include healthcare practitioners acquiring knowledge about BT and its potential advantages [26]. The second phase is persuasive. Once people or organizations have acquired information, they proceed to the persuasive stage. They evaluate the benefits, drawbacks, and suitability of the invention in relation to their requirements and principles [27]. Healthcare stakeholders may assess the potential of BT to enhance data security, interoperability, and patient care. The third phase is decision. At this juncture, prospective adopters make a decision about their acceptance or rejection of

the innovation [27]. Decision-making is impacted by aspects such as the innovation's comparative superiority to current alternatives, its simplicity of implementation, and the anticipated hazards. Within the healthcare sector, this phase entails the deliberate decision of hospitals or clinics to allocate resources towards adopting BT. The fourth phase is implementation [28]. During this phase, the invention is actively applied and executed. Healthcare institutions are considering the use of BT into their systems and procedures. It include pilot initiatives, personnel education, and modifications to the infrastructure [1]. Confirmation is the conclusive phase when adopters assess the outcomes of their adoption choices. They evaluate the influence of the innovation on efficiency, patient outcomes, and other pertinent factors. If the implementation of BT in the healthcare sector is effective, it will become an integral component of standard practice [27]. The DOI is particularly pertinent to the adoption of BT in healthcare due to many factors. Healthcare businesses may use this theory to get insight into the sequential phases of blockchain adoption [25]. It facilitates the identification of the obstacles and possibilities encountered at each level. The idea emphasizes the identification of possible obstacles to adoption, such as resistance to change or doubt on the advantages of BT [26]. Healthcare organizations have the ability to aggressively tackle these obstacles. By identifying innovators and early adopters in the healthcare field, organizations may strategically focus on these individuals to encourage the use of BT among their peers [27]. The theory highlights the significance of analyzing the consequences of blockchain deployment. This enables healthcare businesses to evaluate the influence on patient care, data security, and operational efficiency. Gaining insight into the dissemination of information regarding blockchain may assist healthcare businesses in devising efficient communication strategies to educate stakeholders [27]. DOI provides a structured approach to comprehending the intricate process of blockchain implementation in the healthcare industry [26]. Healthcare companies may make well-informed judgments about deploying BT to enhance the quality and security of healthcare services by understanding the phases of dissemination and the variables that influence adoption decisions.

3.3. Trust Theory

The use of trust theory in healthcare is crucial since it serves as the foundation for the patient-provider interaction, medical decision-making, and the exchange of data [29]. Trust is essential for patients to have confidence in healthcare experts, organizations, and systems, which in turn leads to effective care delivery and excellent treatment results. The confidentiality of patient data is crucial for establishing trust in healthcare [30]. Patients are more inclined to place their faith in healthcare practitioners and organizations that can ensure the confidentiality and integrity of their medical information [31]. Blockchain, because to its robust cryptographic security and inherent immutability, guarantees that once data is recorded, it remains unalterable and inaccessible without proper permission. This develops confidence among patients, as they are assured that their confidential health information is secure [32]. Interoperability and care coordination include the trustworthy exchange of patient information across various healthcare practitioners and systems. In order to provide efficient care coordination and informed decision-making, it is essential for authorized individuals to have confidence in the precision and confidentiality of the data that is being shared [33]. The use of BT enables healthcare professionals to securely and efficiently exchange data, fostering trust by enabling the seamless sharing of patient information while maintaining privacy and data integrity. Trust is built by transparent and automated agreements. Smart contracts on blockchain may streamline hospital operations by automating tasks such as insurance claims, invoicing, and consent management [34]. These autonomous contracts operate according to predetermined norms and have the potential to minimize conflicts or misinterpretations between parties, so fostering confidence in the effectiveness and impartiality of healthcare procedures [34]. Granting patients the authority to assume ownership over their health data is a basic component of trust theory. Patients who own autonomy over their health data and have the ability to securely distribute them to healthcare professionals, researchers, and insurers, when required, are more inclined to place faith in the healthcare system. BT enables patients to retain ownership and control over their health records, in accordance with the principles of trust theory [29]. The fundamental characteristics of blockchain, including its inability to be altered, its use of cryptography for security, its openness, and its lack of central authority, directly tackle the trust-related difficulties in the healthcare industry [30]. BT, with its safe and reliable platform for managing and exchanging data, corresponds with the ideas of trust theory. This is crucial for improving patient confidence in healthcare providers

and the whole healthcare ecosystem. Consequently, blockchain is increasingly being used as a crucial instrument to guarantee the security and confidentiality of patient data, develop trust, and enhance overall healthcare results.

3.4. Transparency theory

Transparency theory, often known as "transparency in governance" or "open government," is a notion that originated largely in the disciplines of political science, economics, and public policy [35]. It highlights the need for more transparency, availability, and responsibility in government and organizational activities. The concept of transparency theory has been applied to other fields, such as healthcare, where it pertains to the use of BT to enhance transparency [36]. The emergence of transparency theory may be attributed to the late 20th century when researchers and policymakers began acknowledging the significance of enhancing the visibility and comprehensibility of information, processes, and decision-making for the public and key stakeholders [37]. The theory became well recognized in conversations around democratic government, accountability, and trust [38]. Transparency theory advocates for the notion that everyone, including citizens, stakeholders, and the general public, should have convenient access to information pertaining to government acts, organizational operations, and decision-making procedures [39]. Accountability emphasizes the need of ensuring that entities are held responsible for their actions, choices, and results. Transparency in procedures and information is crucial for holding people and organizations accountable for their actions. The promotion of transparency fosters the active involvement and commitment of stakeholders in decision-making processes [40]. It promotes active engagement and cooperation between institutions and the public. Blockchain adoption is intricately linked to transparency theory, especially in the fields of healthcare and government. The ledger of blockchain is unchangeable, distributed, and easily observable. Each transaction or data entry is meticulously documented in a way that cannot be tampered with, and the ledger is accessible to authorized parties [41]. The inherent openness of this system allows all necessary parties to view and verify the data directly, without the need for middlemen or centralized authority. Data recorded on a blockchain is unchangeable and cannot be removed once it has been added [42]. The quality of immutability guarantees the integrity and trustworthiness of data. In the healthcare sector, this implies that patient information, medical procedures, and healthcare results may be safely preserved without any worries about unwanted alterations [43]. Blockchain enhances accountability by providing a traceable record of activities and transactions. Identifying the individual responsible for a certain activity, alteration, or access to specific data is made simpler. This is consistent with the ideals of accountability in transparency philosophy [44]. Blockchain allows all authorized stakeholders, such as patients, healthcare providers, and government organizations, to engage in and verify healthcare data [45]. This is consistent with the focus of transparency theory, which prioritizes the enhancement of involvement and active participation in decision-making procedures [46]. BT facilitates open data projects by enabling both public and authorized individuals to access specific data, hence fostering openness in healthcare systems and governance.

3.5. Prior Work

Several studies examined the issue related to the benefits and challenges of using BT. Yaqoob et al. [19] discusses the use of BT in managing healthcare data. They examined the potential benefits and obstacles related to the use of BT in the management of healthcare data. The authors explore the capacity of BT to enhance data exchange among healthcare professionals, patients, and other relevant parties. Issues pertaining to scalability, interoperability, and regulatory compliance are resolved. Future proposals highlight the need of a cohesive structure, standards, and rules for the deployment of BT in the healthcare sector. Gaynor et al. [17] explores the use of BT in the healthcare industry, with a specific emphasis on its possible uses and consequences. The authors examine many scenarios, such as electronic health records (EHRs), clinical trials, and supply chain management. They emphasize the benefits of BT, including enhanced data security, more transparency, and more efficient procedures. The article addresses several challenges, such as regulatory issues, interoperability, and the incorporation of new systems into old ones.

Katuwal et al. [14] provided a preliminary analysis of the use of BT in the healthcare industry, including valuable observations on the existing state and obstacles. The authors explored the capacity

of BT to safeguard healthcare records, oversee pharmaceutical supply networks, and uphold the integrity of data. The challenges pertaining to scalability, energy consumption, and data privacy have been highlighted. Kumar et al. [15] conducted a study to examines the essential prerequisites and difficulties linked to the use of BT in the healthcare sector. The authors explores the potential advantages of BT in guaranteeing the authenticity of medical information, facilitating safe data exchange, and mitigating fraudulent activities. The challenges of regulatory compliance, scalability, and data ownership are resolved. Balasubramanian et al. [20] presents a framework for assessing the readiness of healthcare organizations to embrace BT. The framework offers a systematic method to evaluate the level of preparation of healthcare organizations for implementing blockchain. The framework takes into account several aspects, such as the preparedness of the organization, the preparedness of the technology, and the preparedness of the regulations. It aids healthcare organizations in evaluating their capacity to efficiently adopt and use BT.

Uddin et al. [47] examines the IoT, but also investigates the difficulties and remedies associated with the implementation of BT. The authors explore the function of blockchain in safeguarding IoT data and underscores the need for decentralized and trustless solutions. Issues like as energy consumption, scalability, and integration with IoT devices are resolved. Fusco et al. [18] acknowledge the significance of blockchain in the context of a worldwide health crisis. The study revolves on the pivotal role of blockchain's characteristics, such as its robust security measures and inherent transparency, in effectively addressing pandemics like COVID-19. The unchangeable nature of data on a blockchain may guarantee confidence in health data. The research emphasizes the potential of BT in facilitating contact tracing, securely exchanging health information, and effectively managing the supply chain of healthcare supplies in emergency situations.

Sharma and Joshi [48] conducted a comprehensive analysis of the difficulties encountered by the Indian healthcare sector in using BT. The authors discuss the particular challenges posed by Indian regulations and technology, and emphasize the need of raising awareness and providing education on the advantages of BT. The report emphasizes the need for a tailored strategy in using BT, taking into account the distinct healthcare environment in India. Gökalp et al. [16] provided preliminary insights on the possible use of BT in the healthcare industry, as well as the difficulties associated with its implementation. The authors examined potential areas such as the administration of EHR and the traceability of supply chains. Furthermore, this solution also tackles challenges related to scalability, privacy, and regulatory considerations.

Vishwakarma et al. [49] employed a distinctive methodology by focusing its attention on the use of BT for the purpose of managing the supply chain in the healthcare industry. It demonstrates the potential of BT to improve transparency and traceability in the healthcare supply chain, guaranteeing the authenticity of drugs and medical equipment. The study demonstrates the pragmatic use of BT to enhance the operational effectiveness of supply chains in the healthcare industry. Govindan et al. [50] use a methodical approach to identify and give priority to the obstacles hindering the widespread acceptance of BT in the healthcare sector. They use the Balanced Scorecard framework. The research facilitates the assessment of the strategic use of BT by firms, taking into account many dimensions such as financial, customer, internal process, and learning and development perspectives.

Singh et al. [51] explores the use of BT in improving data management in the healthcare system. This research investigates the use of BT for the purpose of enhancing data management efficiency in the healthcare sector. The authors emphasized the potential for using BT to optimize data management procedures, enhancing both the security and reliability of data. The authors highlight that the unchangeable and secure characteristics of blockchain can greatly improve the administration of healthcare data, hence enhancing the reliability and security of the system. Odeh et al. [52] provided valuable perspectives on the possible advantages and difficulties linked to the use of BT in the healthcare sector. The authors provide a thorough analysis of practical applications, offering a comprehensive exploration of how BT might be used to improve healthcare procedures and the handling of data. Azbeg et al. [10] conducted a comprehensive analysis of the use of IoT and BT in healthcare applications. The study classified and evaluates several scenarios in which IoT and blockchain are used to effectively tackle healthcare obstacles. The taxonomy offers a systematic structure for comprehending the use of various technologies in the healthcare sector.

Akbar et al. [9] use a maturity model to provide guidance to healthcare organizations in their implementation of BT. The study presented a comprehensive analysis of the steps and standards for evaluating the preparedness and advancement of blockchain integration in the healthcare sector, providing a systematic method for embracing this technology. Merlo et al. [8] conducted a systematic review and examined the use of BT in the healthcare industry. The study offers a thorough and organized examination of the present level of blockchain implementation in the healthcare sector. This resource thoroughly explores many applications and problems, making it a great asset for anybody interested in the wide range of opportunities to utilize BT in the healthcare industry. Sutanto et al. [7] examined the incorporation of BT into the health insurance sector in Indonesia. The focus is mostly on using hash authentication to guarantee the security and genuineness of data in health insurance procedures. Prybutok and Sauser [6] investigated the potential of using BT to augment data security, integrity, and access control in healthcare information systems. The study provided valuable insights into the successful integration of BT in the healthcare industry by connecting theoretical concepts with practical applications. Pilares et al. [5] suggested a method that integrates blockchain with the InterPlanetary File System (IPFS) to augment the security, accessibility, and dependability of EHRs in the healthcare sector. The study offers a thorough methodology for enhancing EHR systems via the use of these cutting-edge technologies. Table 1 shows a summary of the key findings of the reviewed articles.

Table 1: Summary of Key Findings

Study	Focus	Key Findings
[19]	BT in healthcare	Examines benefits and obstacles related to BT in healthcare data management. Highlights potential for enhanced data exchange, resolves scalability and interoperability issues, and emphasizes the need for cohesive standards.
[17]	BT in healthcare	Explores BT applications in EHRs, clinical trials, and supply chain management. Emphasizes benefits like enhanced data security and transparency, addressing challenges such as regulatory issues and interoperability.
[14]	BT in healthcare	Provides insights into the use of BT in safeguarding healthcare records and overseeing pharmaceutical supply networks. Highlights challenges related to scalability, energy consumption, and data privacy.
[15]	Challenges of BT in healthcare	Examines potential advantages of BT in ensuring medical information authenticity and safe data exchange. Addresses challenges of regulatory compliance, scalability, and data ownership.
[20]	Readiness for BT adoption	Presents a framework to evaluate healthcare organizations' readiness for BT implementation, considering organizational, technological, and regulatory preparedness.
[47]	Challenges of BT in IoT	Explores BT's role in securing IoT data, addressing issues like energy consumption, scalability, and integration with IoT devices.
[18]	Role of BT in global health crises	Examines blockchain's role, emphasizing security and transparency, in addressing pandemics like COVID-19. Highlights potential uses in contact tracing and supply chain management.
[48]	BT in healthcare	Discusses challenges specific to Indian regulations and technology. Emphasizes the need for awareness and education on BT advantages.
[16]	BT in healthcare	Explores potential uses in EHR administration and supply chain traceability. Addresses challenges related to scalability, privacy, and regulatory considerations.
[49]	BT in healthcare	Demonstrates BT's potential to enhance transparency and traceability in the healthcare supply chain. Emphasizes practical use to improve operational effectiveness.
[50]	Obstacles to BT usage in healthcare	Utilizes the Balanced Scorecard framework to identify obstacles to BT acceptance, considering financial, customer, internal process, and learning and development perspectives.
[51]	BT in healthcare	Explores BT's potential to optimize data management procedures, enhancing security and reliability. Emphasizes blockchain's secure characteristics in healthcare data administration.
[52]	Challenges of BT in healthcare	Provides perspectives on potential advantages and difficulties associated with BT in the healthcare sector.
[10]	IoT and BT in healthcare	Classifies and evaluates scenarios where IoT and blockchain address healthcare obstacles. Offers a taxonomy for comprehending technology use in healthcare.
[9]	BT in healthcare	Uses a maturity model to guide healthcare organizations in BT implementation, evaluating preparedness and advancement systematically.

[8]	Review of BT in healthcare	Offers a comprehensive examination of current blockchain implementation in healthcare, exploring applications and challenges systematically.
[7]	BT into health insurance	Focuses on using hash authentication to ensure data security and genuineness in health insurance procedures.
[6]	BT in healthcare	Investigates the potential of BT to enhance data security, integrity, and access control in healthcare information systems.
[5]	BT with IPFS for EHRs	Suggests a method integrating blockchain with IPFS to enhance EHR security, accessibility, and reliability. Offers a thorough methodology for improving EHR systems with these technologies.

3.6. Differences between Traditional and Blockchain in Healthcare

Within the domain of healthcare data administration, the integration of blockchain technology signifies a notable departure from conventional methods, presenting clear benefits and proposing a fundamental change in the handling of data. Conventional healthcare data systems often depend on centralized databases overseen by a single organization, such as a healthcare provider or institution. Centralized systems are vulnerable to a range of obstacles, such as those of data security, interoperability, and transparency. Blockchain, however, functions on a decentralized and distributed ledger, radically changing the manner in which healthcare data is stored and exchanged. In their study, Yaqoob et al. [19] explore the significant impact that blockchain technology may have on healthcare data management. They highlight its ability to facilitate seamless data sharing among healthcare professionals, patients, and other important stakeholders. The decentralized structure of blockchain guarantees that no one entity has exclusive authority, hence resolving concerns about data security and confidentiality that are inherent in centralized systems. The distributed design not only reduces the likelihood of data breaches but also brings about transparency and tamper-resistance, resulting in the data on the blockchain being unchangeable [5]. In addition, conventional healthcare data systems often face difficulties with scalability, interoperability, and regulatory compliance. In their study, Yaqoob et al. [19] investigate the effectiveness of blockchain in addressing these problems by offering a decentralized framework that enables smooth and safe sharing of data. The unchangeable and easily understood character of blockchain transactions improves the capacity to track and take responsibility for healthcare procedures [17]. Although blockchain offers intriguing benefits, its implementation in the healthcare sector is not without obstacles. Conventional systems possess set frameworks and procedures, and incorporating a new technology such as blockchain necessitates overcoming opposition to alteration. The authors Balasubramanian et al. [20] provide a system to evaluate the preparedness of healthcare institutions in adopting blockchain technology. This framework takes into account the readiness of organizations, technology, and regulations, recognizing the need of a complete strategy while moving from conventional systems to blockchain-based systems. To summarize, the change from conventional healthcare data administration to blockchain-based solutions represents a transition from centralized authority to decentralized, transparent, and secure procedures. The disruptive promise of blockchain technology in the healthcare business lies in its ability to overcome the limits of old systems and improve data security, transparency, and efficiency. Nevertheless, achieving effective implementation necessitates a comprehensive comprehension of the disparities between conventional and blockchain-based methodologies, along with a methodical strategy to surmount related obstacles [17, 20].

4. Findings

Research suggests that BT is being utilized in various areas within the healthcare industry. Some examples of these are data management, supply chain management, insurance, and electronic health records (EHRs). This showcases the adaptability of BT in tackling different obstacles within the industry. Blockchain is widely recognized as a technology that provides numerous benefits to the healthcare industry. Key factors to consider are improved data security, increased transparency, building trust, and ensuring interoperability. The unchanging nature of blockchain records guarantees the integrity of sensitive healthcare data, which is of utmost importance for maintaining patient privacy and safety. The integration of BT in the healthcare industry poses certain obstacles. Identified are scalability issues, regulatory compliance, integration with existing healthcare systems, and interoperability challenges. It is crucial to tackle these concerns in order to effectively implement BT in the healthcare sector. Several

studies offer practical illustrations of how BT has been utilized to tackle specific healthcare obstacles. These practical examples demonstrate the concrete advantages and results of utilizing BT in the healthcare industry. Various studies have put forth maturity models and frameworks for the implementation of BT in the healthcare sector. These frameworks provide guidance for healthcare organizations to evaluate their preparedness and facilitate the systematic adoption of blockchain solutions. Data security and trust are of utmost importance in the healthcare industry. BT is widely regarded as a promising solution for addressing security and trust issues due to its decentralized and tamper-resistant ledger. It offers an additional level of security for confidential patient information. Ensuring the security and immutability of patient data is of utmost importance, and BT plays a vital role in achieving this goal. Interoperability plays a crucial role in determining the effectiveness of blockchain in enabling data sharing and communication among various healthcare systems and stakeholders. Enhancing patient care is greatly improved through achieving interoperability. Healthcare is subject to extensive regulations, and any blockchain implementations in this field must adhere to these regulations. Ensuring compliance with industry standards is crucial for the proper functioning of technology. Maturity models play a crucial role in the development and utilization of various processes. They assist healthcare organizations in evaluating their preparedness for adopting BT and monitoring their advancements in its successful implementation. It is crucial to comprehend the practical applications of BT in the healthcare industry. These examples demonstrate the potential benefits of implementing BT in various industries, including healthcare and logistics. Integration with existing healthcare systems and technologies can be a complex variable. Efficient integration is crucial for the widespread adoption of blockchain, as it allows for seamless collaboration with existing legacy systems. The improvement of healthcare processes through the use of BT is a crucial factor to consider in terms of efficiency. Enhancing efficiency can result in cost savings and the optimization of healthcare operations. Building trust and fostering transparency are crucial elements for the widespread adoption of BT in the healthcare industry. The key features of the technology, such as immutability and transparency, are in line with the fundamental principles of trust and transparency in the healthcare field. The scalability of blockchain solutions is a crucial factor to consider. Healthcare systems produce large quantities of data, and it is crucial for the technology to efficiently manage this data volume. Ensuring data integrity through hash authentication is a crucial factor, as highlighted in a study. Hash authentication plays a crucial role in ensuring the reliability of patient data by verifying the authenticity and integrity of healthcare records. These findings and factors highlight the potential of BT in tackling significant issues in the healthcare sector. In addition, they highlight the significance of security, regulatory compliance, practical applications, and efficiency in real-world healthcare environments. The core attributes of blockchain, including trust and transparency, closely align with the fundamental principles of healthcare data management and security.

5. Discussion

The studies provide a thorough analysis of the opportunities, challenges, and future recommendations for the adoption of BT in the healthcare sector. Together, these studies provide valuable insights into the current state of blockchain in healthcare and its potential to revolutionize the industry. Blockchain has a wide range of applications in the healthcare industry, including data management, supply chain, IoT, and electronic health records (EHRs). The wide range of applications showcased here demonstrates how BT can effectively tackle various issues within the healthcare ecosystem. The studies highlight the advantages of implementing BT in healthcare, such as heightened data security, transparency, trust-building, and improved interoperability. Figure 5 shows the challenges and advantages of BT in healthcare.

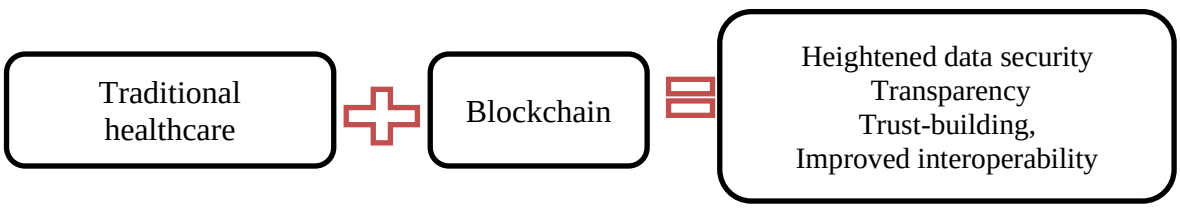

Fig 2: Integrating Healthcare and Blockchain

The advantages mentioned can result in improved and patient-focused healthcare services. Numerous obstacles hinder the adoption of blockchain in the healthcare industry, encompassing scalability, regulatory compliance, system integration, and interoperability. Given the intricate and heavily regulated nature of the healthcare sector, it is imperative to carefully analyze these challenges. The reviewed studies include real-world examples that showcase the practical impact of BT in enhancing patient care, safeguarding patient data, and optimizing healthcare processes. These cases demonstrate the potential benefits of the technology. The studies provide maturity models and roadmaps for healthcare organizations to evaluate their preparedness for adopting BT. These frameworks can assist healthcare providers in effectively adopting and integrating blockchain solutions.

6. Conclusion and Future Work

The results indicate the capacity of BT to transform the healthcare industry. In order to achieve successful adoption, it is crucial to address the challenges that may arise, despite the significant benefits. In order for the technology to thrive in the healthcare industry, it is imperative to focus on scalability, regulatory compliance, integration with existing systems, and promoting interoperability. BT has the potential to strengthen data security, promote transparency, develop trust among stakeholders, and enhance interoperability. It presents the potential for healthcare services that prioritize patients and operate with greater efficiency, in line with the constantly changing demands of the industry. The reviewed studies offer valuable insights into the adoption of blockchain in healthcare, but it is important to acknowledge their limitations. The studies often focus on particular regions, countries, or healthcare settings. The scope of their findings is limited in terms of its applicability to wider contexts. Healthcare systems differ across countries, and what is effective in one context may not be directly applicable elsewhere. The field of BT is experiencing rapid evolution. Certain studies may become outdated as technology advances and new solutions emerge. Certain studies may have limited sample sizes or employ convenience sampling, which can lead to selection bias. Increasing the size and diversity of the samples would strengthen the reliability of the findings. Numerous studies concentrate on particular facets of blockchain adoption in the healthcare industry, such as data management or supply chains. This limited scope may fail to consider the wider ramifications of incorporating BT into the healthcare industry. Certain studies primarily focus on theory and may not provide concrete examples of practical implementation. Some studies may have limitations in terms of the practical insights they offer from real-world applications. Despite the presence of a few case studies showcasing blockchain adoption in healthcare, their quantity and range remain relatively limited. Expanding the scope of case studies would enhance the depth of knowledge gained. The adoption of BT in the healthcare sector is currently at an early stage. Certain studies may fail to capture the long-term trends or challenges that arise with the passage of time in the process of adoption. Multiple studies have emphasized the advantages of implementing BT in the healthcare sector. Nevertheless, the advantages of these benefits are frequently taken for granted instead of being rigorously evaluated or proven through extended practical application. Numerous studies recognize the intricate nature of regulations pertaining to healthcare data. However, it is possible that they do not delve deeply into the complexities of compliance and regulation, which can differ greatly between different regions. Future research should focus on addressing these limitations to gain a more comprehensive and practical understanding of blockchain adoption in healthcare. This will help uncover the implications, challenges, and opportunities associated with this technology. Additional research can explore specific implementations of blockchain in the healthcare sector, assessing their efficacy and influence on patient care and data management. Given the critical importance of data security and patient privacy in the healthcare sector, it would be valuable to further investigate the ways in which blockchain solutions effectively tackle these concerns. Further research is required to explore the potential of blockchain in resolving the interoperability challenges faced by the healthcare sector. One aspect to consider is the analysis of how blockchain can be integrated with current systems and standards. Additional research can be conducted to examine the regulatory obstacles and compliance obligations associated with the implementation of BT in the healthcare sector. Further elaborating on maturity models and roadmaps can offer healthcare organizations more comprehensive guidance for implementing blockchain solutions. Overall, the studies present a positive

perspective on the potential of blockchain in healthcare. They emphasize the importance of further research to overcome obstacles and fully capitalize on the advantages of this revolutionary technology.

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اعتماد البلوك تشين في الرعاية الصحية: النماذج والتحديات والعمل المستقبلي

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الملخص

لقد نشأ استخدام تقنية البلوك تشين كعلاج فعال لمعالجة التحديات الحاسمة في قطاع الرعاية الصحية، بما في ذلك أمن البيانات وقابلية التشغيل البيني والشفافية. يعد دمج تقنية البلوك تشين في صناعة الرعاية الصحية واعدًا جدًا، ولكنها عملية معقدة تتأثر بعدة متغيرات. تسعى هذه المراجعة المنهجية إلى توفير فهم شامل للنماذج والعقبات والأبحاث القادمة المتعلقة باستخدام تقنية البلوك تشين في قطاع الرعاية الصحية. تتناول هذه الورقة الأفكار والنماذج الأساسية التي تعتبر حاسمة في فهم تنفيذ تكنولوجيا البلوك تشين في قطاع الرعاية الصحية. النظريات المدرجة في هذه القائمة هي نموذج قبول التكنولوجيا، ونظرية نشر الابتكار، ونظريات الثقة والشفافية. توفر هذه النظريات معًا إطارًا منهجيًا لتقييم عملية التبني. توفر نتائج المراجعة المنهجية نظرة عامة على الوضع الحالي لتطبيق البلوك تشين في قطاع الرعاية الصحية. وتشمل التحديات التي تم تسليط الضوء عليها العقبات المتعلقة باللوائح، والصعوبات في تحقيق قابلية التشغيل البيني، والمخاوف بشأن خصوصية البيانات، والحاجة إلى بنية تحتية قوية وموثوقة. علاوة على ذلك، تشمل مزايا استخدام تقنية البلوك تشين حماية متزايدة للبيانات وزيادة خدمات الرعاية الصحية.

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