LEX LOCALIS-JOURNAL OF LOCAL SELF-GOVERNMENT
ISSN:1581-5374E-ISSN:1855-363X
VOL.23,NO.S5(2025)

BLOCKCHAIN TECHNOLOGY AND ITS APPLICATIONS IN SAUDI ARABIA: AN ANALYTICAL STUDY

Wiem Abedelmonem Salah Ben Khalifa[1], Waed Waleed Al-abweeny[2], Nouf Mohammed Almajel[3], Omima Kmaleldian Hassan Mhamed[4]

[1]Information Science Department, College of Arts, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia
https://orcid.org/0000-0003-0776-2748
[2]Information Science Department, College of Arts, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia
https://orcid.org/0000-0002-5207-4429
[3]Information Science Department, College of Arts, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia
https://orcid.org/0009-0006-6447-0230
[4]Information Science Department, College of Arts, Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia
https://orcid.org/0000-0003-1990-159X

wabenkhalifa@iau.edu.sa[1]
walaboweeny@iau.edu.sa[2]
nmaloaqiel@iau.edu.sa[3]
okhassan@iau.edu.sa[4]

Abstract
Blockchain is a decentralized digital registry technology that imparts high security to record transactions by sharing the information in several computers across the globe and making it unchangeable and trusted through consensus. Initially created to resolve the issue of double-spending with digital currencies such as Bitcoin, blockchain currently finds applications beyond the financial industry to improve transparency, security, and efficiency in a wide range of industries. The paper examines the conceptual background of blockchain, its implementation and the application in Saudi Arabia, particularly in the realms of finance, healthcare, supply chain, government, and education in line with Saudi Vision 2030.Although the global community grows, blockchain adoption in Saudi Arabia is still very young with industry-specific applications in Islamic finance, electronic payments, electronic health records, and academic authentication, yet no widespread cross-sector frameworks and comprehensive policies. The paper notes that the number of blockchain businesses in Saudi Arabia is growing substantially due to government efforts and regulatory changes, as well as market valuation and adoption of other new technologies such as AI and IoT. It highlights the transformational potential of blockchain to grow the digital economy and smart city building and the importance of considering the technical, legal, and organizational barriers.It would be recommended to further develop field research on adoption, investigate synergies between blockchain and AI, and compare the progress of Saudi Arabia with its counterparts in the Gulf to inform policies and broad blockchain strategies that facilitate sustainable national digital transformation.

Key words: Blockchain Adoption; Saudi Arabia; Vision 2030; Regulatory Challenges

Introduction

Blockchain is a digital ledger that encrypts information so it is very difficult to alter or fraud. Instead of the data being housed in one place, in one computer, it is divided among a large number of computers in separate locations around the world - each computer stores and verifies the information. This gives blockchain a large degree of security and trustworthiness as there is no way for a single individual or group to change the recorded data without the others being aware **[1].** Basically, information is grouped into blocks, which are connected by a chain. Each block

contains a list of transactions and a unique code known as a hash that links the block to the preceding block. And this connection ensures that the data cannot be tampered with. Further, new information is added only after the majority of computers agree that it is legitimate - a consensus **[2].** Blockchain is not just used to facilitate digital money such as Bitcoin. It is useful wherever trust, transparency and security are of high importance. For instance, it can trace goods from factories to shops, secure medical records, or deal with contracts automatically with the use of so-called "smart contracts" - programs running on the blockchain that are like computer programs **[1].**

Problem statement and Gap of Studies

The blockchain technology presents disruptive opportunities in all sectors, as it enables greater transparency, security, efficiency, and decentralization. Although globally, there is an increase in utilizing and applying blockchain, the use and application of blockchain in Saudi Arabia is still in its fledgling stages with little holistic research on the various applications of blockchain. The study of feasibility, challenges and industry-specific uses of blockchain in Saudi Arabian unique social, economic, regulatory and technological settings are also required to inform viable policies and strategies to utilize the benefits of blockchain in accordance with the Saudi Vision 2030.

Associated with gab of studies, a larger number of studies are limited to a few sectors like Islamic financial products (Al Rajhi Bank), performance of supply chain in industrial companies, healthcare records (Sehhaty Platform), small and medium enterprises (SMEs) and education to authenticate academic documents. There is little literature on cross-sector integration and universal frameworks or guidelines on blockchain adoption that can be used across more than one sector. Scalability, privacy issues, regulatory compliance, interoperability and barriers to user adoption are all recognized as key challenges but there are few comprehensive, sector wide solutions or policy frameworks. Little attention is paid to new applications of blockchain, including the use of cryptocurrencies, electronic payments, logistics, automation of telemedicine prescriptions, and sustainable development efforts. Further, there are a limited number of qualitative and mixed-method studies that capture the views of stakeholders in a holistic manner in government, the private sector, academia and end-users. There is limited research on how leadership, governance, and cultural issues can influence the adoption of blockchain, particularly among SMEs and public institutions.

This technology of blockchain and its various applications in Saudi Arabia study would fill these gaps by giving a comprehensive analysis of blockchain technology in the various sectors.

Objectives of the study

- To explore the basic concepts and technology behind blockchain, such as how it works and its core aspects like decentralization, immutability, and transparency
- To determine and evaluate the various applications of blockchain technology in various sectors in Saudi Arabia, such as finance, supply chain, healthcare, government services, and real estate.
- To establish the current adoption level of blockchain technology in Saudi Arabia and to address the factors that are going to facilitate its implementation or that are going to hinder it.

Definitions of Blockchain and The Reasons Behind Its Emergence

The definition of a blockchain technology according to **[3]** is: blockchain technology is an advanced technology which has a strong database where information can be shared clearly within a network with data stored in blocks forming a chain. Since it was created in 2008, this technology

has evolved and supports many applications other than digital currencies. It is also defined by **[4]** as a distributed ledger technology that uses cryptography to make the data immutable and to assure integrity. Blockchain allows for secure, transparent and decentralized transactions, revolutionizing various industries through the elimination of centralized control. Blockchain is also described as a distributed chain of blocks that records the history of transactions and user data working on decentralized principles. The network supports transactions in an open environment, which is highlighted by digital cryptocurrencies **[5].**

With respect to its reasons for emergence, it is evident that Blockchain technology came mainly as a solution to key issues concerning digital transactions and trust. One of its main purposes was to solve the so-called "double spending" problem in digital money, where a digital token could be copied and spent more than once. Traditional digital currency systems depend on a centralized authority, such as a bank, to avoid this. Blockchain established a means for multiple users to have a safe, unchangeable ledger which logs transactions transparently, so nobody can spend the same money twice without everyone else's knowledge **[1].**

Another reason for the emergence of blockchain was a necessary trust between individuals or entities who do not necessarily trust each other in a transaction. Blockchain eliminates the middlemen and trusted third-party requirements through a decentralized system. This makes the transactions fast, cheaper, and secure as the network of computers will all check and record the transactions **[6].**

Advances in cryptography and computer networks also were important. Thanks to distributed computing and public-key cryptography, a system could be built to prevent attacks and keep the same ledger on multiple participant's computers-and let them update the ledger without hacking the others. The combination of these ideas into a working system for digital money was popularized by the mysterious creator of Bitcoin, Satoshi Nakamoto, who released it in 2008, which then inspired broader applications beyond currency **[7].**

The History of Blockchain

Beginning with the earliest ideas of securing digital records in the 1990s, blockchain technology's origins lie in foundational ideas of creating an immutable and decentralized ledger for digital transactions. The way we know about blockchain today, the concept starting to truly take shape was in 2008 as the Bitcoin whitepaper was published by the pseudonymous Satoshi Nakamoto. This was the birth of the first decentralized cryptocurrency, Bitcoin, which utilized blockchain technology to offer a secure and trustless method of recording monetary transactions without referrals such as banks **[8].**

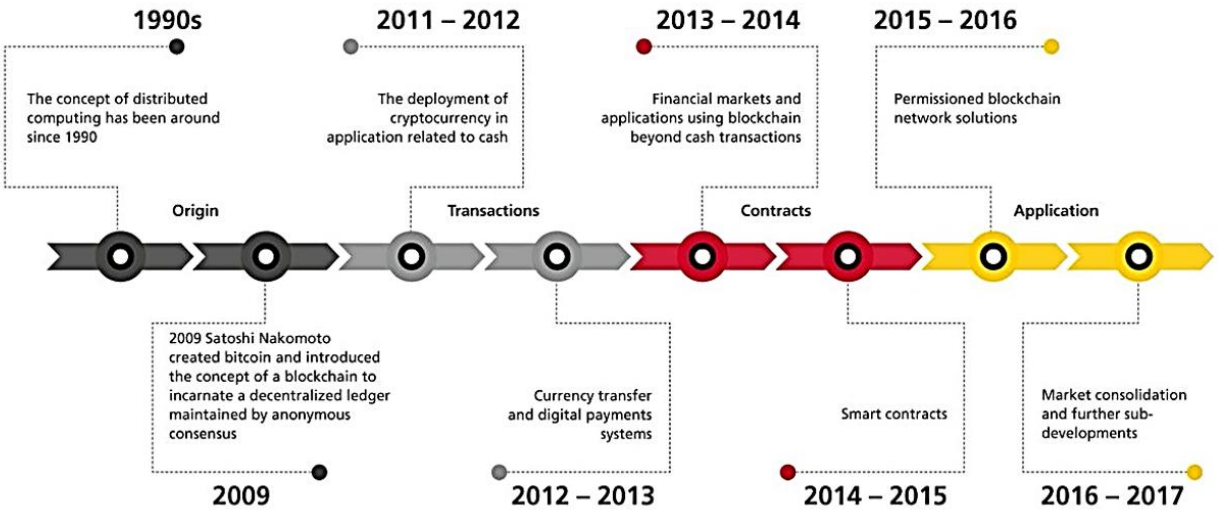

Figure 1: Timeline and The History of Blockchain **[9].**

Before Bitcoin, the concept of a secure digital ledger already existed in cryptography and computer science and technologies such as public-key encryption and distributed databases had already been studied. However, the biggest leap in blockchain was combining these technologies to form a peer-to-peer network that could record transactions in a tamper resistant way with consensus validation. Bitcoin's blockchain is the first large-scale application of this technology, laying the foundation for wider uses in more than just cryptocurrency **[1-4].**
After Bitcoin was launched, blockchain development exploded. In 2015, Ethereum launched a new blockchain platform allowing smart contracts, which allows for programmable transactions and decentralized applications. This innovation expanded the use cases of blockchain from just currency to fields of finance, healthcare, supply chain management, and even the arts. Over the next several years, work centered on scalability, interoperability, and increasing security, while governments and private enterprises experimented with blockchain for a variety of economic and social uses **[6].**

The Bitcoin's launch

Bitcoin was first issued in 2008 by an unknown person, or group, under the pseudonym Satoshi Nakamoto, as the first decentralized cryptocurrency with the publication of a white paper. The purpose was to develop a digital currency system where a centralized authority is not in existence, and transactions are validated and recorded using a new technology known as blockchain, which is a transparent and secure method of recording transactions. This new currency was intended to establish a monetary system free from the conventional banking system; it replaces the more traditional trust-based mechanisms with a technology-driven language for money **[10].**
The actual Bitcoin network was formed on January 3, 2009 when Nakamoto mined the first block of the Bitcoin blockchain known as the "genesis block" on a personal computer CPU. This was the inauguration of Bitcoin as a fully-functional cryptocurrency system. Initially, Bitcoin was considered as a new and inventive financial technology that can potentially transform the way of monetary relations by supporting trustless transactions validated by cryptographic proofs without any intermediaries **[11].**

Bitcoin's debut has been credited as a major financial innovation that ushered in a new era of decentralized digital currencies and blockchain technology, affecting many developments that would follow in cryptocurrencies and digital assets. Despite doubts from some and predictions of its demise, Bitcoin has since become an important, albeit volatile, digital asset with a complex socio-economic impact and ecological mining footprint since its inception **[8].**

The structure of Blockchain

Blockchain is a distributed ledger technology that is decentralized and comprised of a chain of blocks. Each block includes a list of transactions and metadata related to those transactions, and it has a cryptographic seal connecting it to the block before it (immutability - once a block is inserted, it cannot be edited or deleted). This chain structure ensures transparency, data integrity and security in a trustless network **[12].**

At a granular level, the blockchain has several key elements: blocks, which store the transaction data; cryptographic hashes, which tie each block tightly to its predecessor; a consensus system, which ensures distributed nodes agree on a transaction's validity; and a peer-to-peer network infrastructure, where nodes individually store and verify the blockchain ledger. This architecture removes the need for centralized intermediaries, promoting decentralized digital asset transfers and secure, fraud and censorship-resistant data management **[13].**

The architecture can also be seen as a layered architecture made of: the data layer (blocks, transactions, hashing); the network layer (nodes, communication protocols); the consensus layer (e.g. Proof of Work or Proof of Stake validating blocks); and the application layer (smart contracts, dapps). Together, these layers allow blockchain to offer immutability, transparency, traceability, and decentralized data storage for a large number of applications beyond cryptocurrencies **[12,13].**

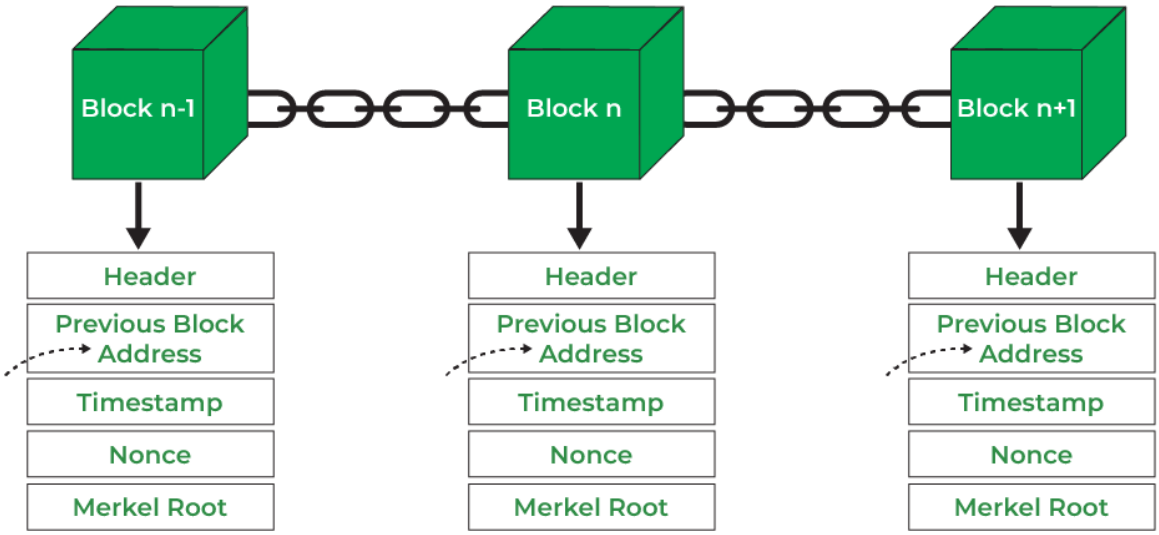

Figure 2: The structure of Blockchain **[14]**

Advantages of Blockchain Technology

- **Decentralization**

Blockchain technology has several important benefits that have contributed to its growing use in a number of industries. One of the main advantages of blockchain is its decentralization, meaning

that it doesn't rely on a central authority, and instead it spreads the ledger across a large network of computers. This decentralization increases security and transparency, because transactions are recorded in an immutable manner, and can be validated by everyone involved, minimizing the risk of fraud and tampering **[15].**

- **Efficient and cost-effective**

Another important benefit is the increased efficiency and low costs in the transaction processing. Blockchain can help speed and reduce the cost of cross-border payments and reduce transaction costs for commercial banks and other businesses by simplifying services such as bill processing and asset securitization. This efficiency gain is also observed in industries like real estate where blockchain shortens transaction time and expenses via automated smart contracts and transparent documentation of transactions **[16].**

- **More trust and security**

Blockchain technology also enhances supply chain and logistics systems by offering a secure and transparent traceability of the entire process, thus increasing trust. This transparency reduces the risk, increases information flow, and sustains the sustainable practices, which all lead to better supply chain performance and a competitive edge **[16].**

- **More accuracy**

Additionally, blockchain's security features enable digital transformation in different sectors by offering secure digital archives, improving data accuracy, and guaranteeing record authenticity. These properties, in particular, are significant in notary services, healthcare, and public administration, where integrity and verifiability of documents and transactions are extremely important [**15,16**].

Disadvantages of Blockchain Technology

While the benefits of blockchain technology are vast, there are a few disadvantages as well. One of the great difficulties is scalability. As the number of transactions grows, public blockchains such as Bitcoin and Ethereum hit the limits of transaction throughput and latency. This can result in slower block times and increased transaction costs, which can decrease the efficiency of blockchain for higher volume use cases **[17].** Another big drawback is high energy use, particularly for blockchains using Proof of Work consensus mechanisms. The computing resource required for mining is massive and this consumes a large amount of electricity, increasing the environmental impact and the costs of operations **[17].**

Despite the technology's decentralized nature, security and privacy concerns continue to be a concern. While blockchain enables transparency and data immutability, it is susceptible to attacks such as 51% attacks, smart contract bug, and failure in preserving privacy because data on a public blockchains are exposed to all participants **[18].**

In addition to these technical challenges, blockchain adoption faces legal challenges due to interoperability problems and uncertainties. Different blockchain platforms tend to lack standards for interaction to flow smoothly, resulting in siloed ecosystems. Besides, regulatory frameworks for blockchain applications, such as intellectual property management and data privacy, are not yet mature, which results in ambiguity for businesses and users **[18].** Finally, blockchain technology can be complex, which can create a barrier to entry. Specialized knowledge is required

to develop, deploy, and maintain blockchain solutions, which could result in high initial costs and significant effort be needed for integration in existing systems **[17,18].**

The Applications of Blockchain Technology in Saudi Arabia

- **In the financial sector**

Blockchain technology has been employed in Saudi Arabia in different ways, with significant effects on finance, healthcare, government services and religious management sectors. One of the key applications is within the financial industry, where blockchain is being used to improve digital payment methods as seen through STC Pay. This application enhances security, transparency, and operational efficiency by overcoming scalability and regulatory compliance issues to provide a robust digital payment platform. Second, blockchain plays a major role in the intricate logistics of the Hajj and Umrah pilgrimages to handle millions of pilgrims' data and activities more efficiently, transparently, and securely, benefiting from the internal characteristics of blockchain (transparency and disintermediation **[19].**

- **In the healthcare sector**

In the healthcare sector, Saudi Arabia is using blockchain in Electronic Health Records (EHRs) to improve the security, integrity, and patient control of medical data. Through decentralized technologies such as Ethereum and IPFS for resilient data storage, patients can have secure control over the access to their health information, reducing the risk of data breaches and unauthorized control in centralized data storage. In a similar way, blockchain is advantageous to the pharmaceutical supply chain as it enhances traceability, transparency, and the exchange of information between stakeholders to ensure drug safety and supply efficiency **[20].**

- **Integration with Vision 2030 digitalization goals**

Further, due to their potential for supporting the government's digitalization goals under Saudi Arabia's Vision 2030, blockchain is a powerful tool for supporting initiatives. The technology is being used in smart city projects to provide citizen services by combining with other technologies like AI and IoT to increase transparency, the privacy of data, and trust in e-governance systems. Cryptocurrency tax administration also examines blockchain applications to address tax administration challenges prevailing in the Ministry of Zakat and Tax by suggesting frameworks to streamline tax processes with the help of immutable ledgers and smart contracts. In the field of education, blockchain is used for the purpose of proving academic records in order to avoid fraud and simplify certification processes of students, both from the native country and international students **[21].**

The current adoption level of blockchain technology in Saudi Arabia

Blockchain technology has gained a degree of implementation in Saudi Arabia that is notable and is rapidly increasing. As of Q2 2025, there are over 4,000 blockchain companies officially registered in the country - a significant 51% year-on-year rise in blockchain business registrations. More than 2,400 blockchain-related companies are based in Riyadh, the biggest center, followed by Makkah and the Eastern Province. This increase not only reflects increased local entrepreneurship, but also increased foreign investment, in particular through recent regulatory reforms that make it easier to set up and operate a business on a single license nationwide. This increase in registrations is consistent with Saudi Arabia's Vision 2030 vision, which aims to

diversify the economy and advance digital transformation, positioning the Kingdom as a regional technology powerhouse **[22].**

The blockchain market in Saudi Arabia was valued at USD 0.23 billion in 2024 and is expected to grow at a CAGR of 65.5% between 2025 and 2033 to an exponential USD 35.52 billion by 2033. This flourishing is backed by strong government support, including the Saudi Blockchain Initiative which seeks to encourage transparency, efficiency and innovation across sectors such as finance, healthcare, supply chain and smart city developments such as NEOM. The government's strategic vision is promoting public and private investments to facilitate adoption of fintech, digital payments, logistics, and other industries. Collaboration with Technological Companies and Regulatory Sandbox Programs: Regulatory sandbox programs and partnerships with technology companies accelerate innovation while maintaining regulatory compliance, further increasing confidence in the use of blockchain in the Kingdom **[23].**

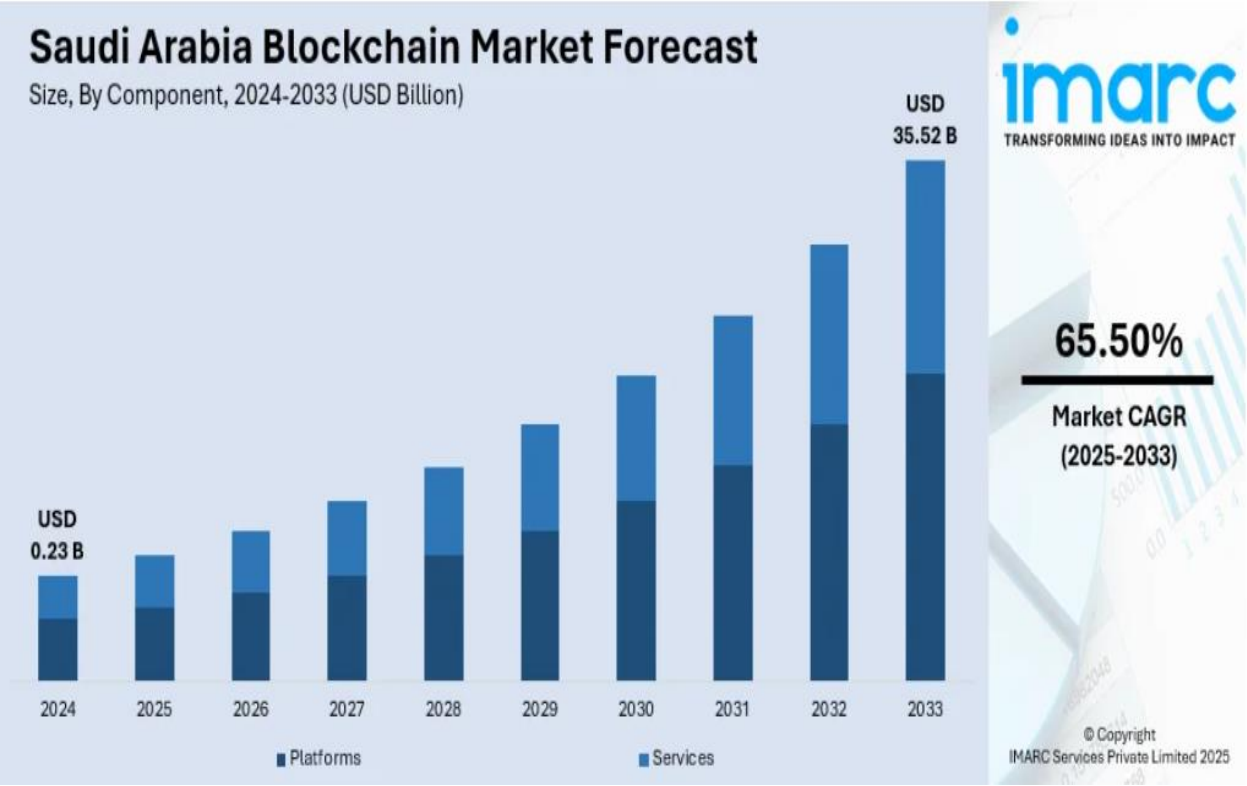

Figure 3: Saudi Arabia blockchain market growth **[23].**

Beyond business growth there is significant demographic heterogeneity in blockchain activity. Women account for almost half of all new commercial licenses issued in Q2 2025 across sectors, as gender inclusion in blockchain and related digital sectors continues to improve. In addition, the growing ecosystem also receives the benefit of synergy with other parallel technologies such as artificial intelligence and cloud services, forming a synergistic integrated solution for enterprise blockchain applications. Overall, Saudi Arabia's blockchain adoption is marked by strong government support, regulatory clarity, technological innovation, and market enthusiasm, making the country a regional leader in blockchain technology adoption **[24].**

The factors driving or hindering the implementation of blockchain technology in Saudi Arabia

One of the main reasons for the adoption of blockchain in Saudi Arabia is the potential for greater security, transparency, and efficiency in various industries, including finance, supply chain, and smart city services. For small and medium enterprises (SMEs), blockchain can help cut operating costs, enhance access to funds, and provide transparency, which can aid economic and social development. Leadership is key to overcoming the adoption challenges, and use of digital technologies, and policy and regulatory trends favouring digital technologies are furthering blockchain applications. Furthermore, blockchain, in conjunction with technologies such as the Internet of Things (IoT), will help increase supply chain sustainability and effectiveness, especially in areas such as pharmaceuticals by solving problems such as transparency, coordination, and product tracking **[25,26].**

The government's Vision 2030 plan is a big enabler of this - focusing on smart cities, e-governance and innovation - where the adoption of blockchain in citizen service delivery is a shallow value proposition. Blockchain-based solutions in the public sector will require robust ethical principles, data privacy and security, and transparency to build trust. Blockchain and cryptocurrency are gradually but cautiously taking hold in Saudi Arabia's finance and technology space (FinTech), driven by their potential advantages of low transaction costs, convenience, and efficiency in payment systems. User education and perceived trust and usefulness play a key role in broader cryptocurrency adoption **[21].**

However, there are a number of factors that impede blockchain adoption. Regulatory and legal hurdles: Blockchain applications such as smart contracts need to be aligned with existing legal frameworks in the Kingdom of Saudi Arabia, presenting regulatory and legal challenges. This includes balancing technology-driven operations with existing legal norms and achieving regulatory compliance. Scalability, interoperability, privacy issues, and integration with legacy IT systems are some of the technological issues that are addressed. Mostly businesses suffer from lack of digital readiness and capacity which makes it difficult to fully utilize blockchain. In addition, adoption in government and enterprises is hampered by cultural factors and organizational resistance **[27].** Table 1 showed the various applications of blockchain technology in various sectors in Saudi Arabia.

Results and Discussion

Blockchain technology's underlying principles - decentralization, immutability, and transparency - are central to its adoption and real-world applications. Decentralized: The decentralized nature of blockchain removes the reliance on central authorities, thereby increasing the security and trustworthiness of data. This has had an impact on industry sectors that require high integrity and traceability, including finance, healthcare, and supply chain management. The blockchain's layered design and consensus protocols add to the trust and tamper-proof aspect that makes it stand out from conventional databases.

Author	Sector	Aim of the study	Example of Application	Findings
(Qatran, 2025) [28]	Finance (Islamic Banks)	This study investigated the possibility of applying blockchain technology to Islamic financial engineering products in Saudi Islamic banks, focusing on the case study of Al Rajhi Bank.	Blockchain in Islamic financial engineering products (Al Rajhi Bank)	Enhances transaction transparency, security; reduces operational costs and fraud risks; initial positive results noted.
(Abaker, 2025) [19]	Digital Payments	This research explores the opportunities and obstacles associated with blockchain, with a particular focus on its application within STC Pay in Saudi Arabia	STC Pay blockchain application	Increases security, transparency, and efficiency; challenges include scalability, privacy, regulatory compliance.
(Masmoudi & Saeed, 2024) [20]	Healthcare	The research delves into the current state of e-HealthCare in Saudi Arabia, examines the challenges faced by existing EHR systems, and introduces blockchain technology, particularly Ethereum, as a viable and transformative solution.	Electronic Health Records (EHR) management with Ethereum	Decentralized control by patients, secure sharing using blockchain, improved data integrity and confidentiality.
(Alshahrani, 2024) [29]	Pharmaceuticals	This study presents a model that can provide a token-based blockchain that will help provide a cost-efficient and secure system for a reliable drug supply chain.	Drug supply chain tracking using blockchain and IoT	Ensures traceability, transparency, and proper medicinal storage, prevents loss of info and fraud.
(Al-Subaie & ageeli , 2024) [30]	Healthcare Records	The study aimed to identify the role of medical records management in activating knowledge management applications in private hospitals	Medical records management in hospitals	Vital for knowledge sharing and research, supports Vision 2030 health goals; blockchain potentially enhances data sharing.
(Mutahhar et al., 2025) [31]	Transportation	This study examines the incorporation of blockchain technology into Saudi Arabia's Intelligent Transportation Systems (ITS), concentrating on enhancing the bus permission procedure for religious mass gatherings in Makkah.	Intelligent Transportation Systems (ITS)	Blockchain applied for optimizing bus permits during mass gatherings, improves management of transport systems.
(Alkhodre et al., 2019) [32]	Taxation	The author present the idea of utilizing Blockchain to design a Value-Added Tax (VAT) system for Saudi Arabia's newly introduced tax system.	Blockchain-based VAT system	Provides immutable, tamper-proof transaction records via smart contracts, enhancing tax compliance and transparency.
(Hajr et al., 2023) [33]	E-commerce	This study develops a hypothesis to investigate and test the impact of Bitcoin on E-Commerce use in Saudi Arabia using a survey research approach.	Bitcoin and blockchain in Saudi e-commerce	Potential to improve e-commerce transparency and payment security; regulatory environment still evolving.

(Alsaadi & Bamasoud, 2021) [34]	Education	To review the blockchain technology and its benefits in relations to education system.	Blockchain in education systems	Secures communication and verification processes; supports accessibility and decentralized record-keeping in education.
(Obidallah et al., 2024) [35]	Construction	This research investigated how the Technology Acceptance Model (TAM) applies to adopting blockchain technology among Saudi Arabian Construction companies.	Blockchain adoption in construction industry	Examines adoption drivers using TAM model; focus on improving transparency and reducing costs in Saudi construction projects.

Table 1: Applications of Blockchain technology in various Saudi Arabia sectors **[By the researcher]**

The adoption of blockchain in Saudi Arabia is currently growing across various sectors, in line with the trend in other parts of the world but with a particular focus on the local policies and the Vision 2030 objectives. Operational Efficiency: Blockchain has demonstrated its value in the financial sector, particularly in the realm of digital payments, where it can increase efficiency and transparency. Blockchain's use in electronic health records and pharmaceutical supply chains has led to improved control of patient data and drug traceability, further ensuring higher standards of care and safety within the healthcare industry. Government projects also use blockchain for e-governance and smart city projects and are part of the national strategy for digital transformation. Significant growth in the number of blockchain companies registered and the market is forecasted to expand reflect robust government support and entrepreneurial activity in the Kingdom. These advancements are supported by reforms that reduce regulatory challenges, gender-inclusive engagement, and the convergence of blockchain with artificial intelligence and cloud computing, heralding a maturing and diversified ecosystem.

However, there are certain challenges that may restrict the full adoption of blockchain in Saudi Arabia. Scalability, energy consumption (some consensus algorithms are more energy-intensive than others), and interoperability concerns impact the technology's operational efficiency and sustainability. Uncertainties in regulation and laws: These challenges arise especially in situations where the currently existing policies have to be reconciled with the decentralized operation of the blockchain. Furthermore, in many sectors, integration remains at a low pace due to cultural and organizational resistance as well as the lack of digital readiness and specific expertise. In order to fully achieve the transformative potential of blockchain, there are significant challenges to address in the areas of policy design, education, and technology development.

Empirical findings from industry-specific research validate the feasibility and constraints of blockchain use cases in Saudi Arabia. For instance, blockchain helps in Islamic finance to provide transparency in transactions and prevent fraud and also in transportation management system for religious mass gatherings. Blockchain is proving useful in the area of tax compliance and education record verification, with smart contracts and immutable ledgers. However, issues surrounding

privacy, scalability, and regulatory alignment continue to be challenges to overcome, highlighting the need for continued innovation and adaptive governance.

Conclusion and Recommendations

With its potential to offer increased security, transparency, and operational efficiency, Blockchain technology holds a transformative potential for Saudi Arabia's economic and digital landscape, particularly in high-impact sectors. The decentralized nature of the blockchain fundamentally alters the way trust and data integrity is handled, contributing towards the nation's Vision 2030 goals on digital innovation and smart city development. With fast-growing blockchain technology use cases, alongside government backing, Saudi Arabia is a regional leader in blockchain adoption. However, scalability, interoperability, and legal matters must be dealt with for successful blockchain integration. Clarity of the regulatory environment, investment in capacity building and organizational openness to change are vital to address adoption barriers. Continued sector-specific research and public-private partnership will be imperative to unlocking the full potential of blockchain to ensure it can efficiently support the Kingdom's modernization and digital transformation ambitions. Based on the previous, the researcher recommends the following:

- The need for field studies on blockchain adoption in Saudi universities.
- The need to study the role of artificial intelligence integrated with blockchain in healthcare or smart cities.
- The need to compare the level of adoption between Saudi Arabia and other Gulf countries.

References

1. Dong S, Abbas K, Li MY, Kamruzzaman J. Blockchain technology and application: an overview. PeerJ. 2023 Nov 29;9(1):e1705–5.
2. Amponsah AA, Felix A, Asubam B. Blockchain in Insurance: Exploratory Analysis of Prospects and Threats. International Journal of Advanced Computer Science and Applications. 2021;12(1).
3. Gurnani B, Kaur K, Morya AK. Adoption, implementation, definitions, and future of blockchain technology in ophthalmology. Indian Journal of Ophthalmology. 2023;71(3).
4. Litoussi M, El Makkaoui K, Ezzati A. An overview of Blockchain: Definitions, architecture, versions, applications and future directions. Journal of digital science. 2023 Jun 25;5(1):3–11.
5. Tripathi G, Ahad MA, Casalino G. A Comprehensive Review of Blockchain technology: Underlying Principles and Historical Background with Future Challenges. Decision Analytics Journal [Internet]. 2023 Dec 1;9(1):100344. Available from: https://www.sciencedirect.com/science/article/pii/S2772662223001844
6. Fiore M, Mongiello M. History of Blockchain Technology and its Impact in Social Good. 2023 Sep 7;36–8. Available from: https://ieeexplore.ieee.org/document/10365852
7. Sebastian M. Cryptographic milestones: Origins, modern algorithms, and the quantum era. World Journal of Advanced Engineering Technology and Sciences [Internet]. 2025 May 30 [cited 2025 Aug 19];15(2):387–93. Available from: https://journalwjaets.com/node/663
8. López-Sorribes S, Rius-Torrentó J, Solsona-Tehàs F. A Bibliometric Review of the Evolution of Blockchain Technologies. Sensors. 2023 Mar 16;23(6):3167.
9. Srivastava V. History and Evolution of Blockchain [Internet]. www.includehelp.com. 2022. Available from: https://www.includehelp.com/blockchain/history-and-evolution.aspx
10. Cocco L, Marchesi M. Modeling and Simulation of the Economics of Mining in the Bitcoin Market. Georgantzis N, editor. PLOS ONE. 2016 Oct 21;11(10):e0164603.

11. Ornes S. Core Concept: Blockchain offers applications well beyond Bitcoin but faces its own limitations. Proceedings of the National Academy of Sciences. 2019 Oct 15;116(42):20800–3.
12. Akcora CG, Gel YR, Kantarcioglu M. Blockchain networks: Data structures of Bitcoin, Monero, Zcash, Ethereum, Ripple, and Iota. WIREs Data Mining and Knowledge Discovery. 2021 Nov 17;12(1).
13. Deng W, Huang T, Wang H. A Review of the Key Technology in a Blockchain Building Decentralized Trust Platform. Mathematics. 2022 Dec 26;11(1):101.
14. Geeks for Geeks. Blockchain Structure [Internet]. GeeksforGeeks. 2022. Available from: https://www.geeksforgeeks.org/ethical-hacking/blockchain-structure/
15. Krichen M, Ammi M, Mihoub A, Almutiq M. Blockchain for Modern Applications: A Survey. Sensors [Internet]. 2022 Jul 14;22(14):5274. Available from: https://www.mdpi.com/1424-8220/22/14/5274
16. Wu B, Duan T. The Advantages of Blockchain Technology in Commercial Bank Operation and Management. Proceedings of the 2019 4th International Conference on Machine Learning Technologies. 2019 Jun 21;
17. Khan D, Jung LT, Hashmani MA. Systematic Literature Review of Challenges in Blockchain Scalability. Applied Sciences [Internet]. 2021 Oct 9;11(20):9372. Available from: https://www.mdpi.com/2076-3417/11/20/9372
18. Golosova J, Romanovs A. The Advantages and Disadvantages of the Blockchain Technology. 2018 IEEE 6th Workshop on Advances in Information, Electronic and Electrical Engineering (AIEEE) [Internet]. 2018 Nov;1(1). Available from: https://ieeexplore.ieee.org/abstract/document/8592253
19. Abaker AA. Evaluating the Opportunities and Obstacles of Blockchain Technology in Saudi Arabia: A Case Study of STC Pay in Modern Applications. International Journal on Cybernetics & Informatics. 2025 Mar 28;14(2):01-19.
20. Masmoudi A, Saeed M. Blockchain-Driven Decentralization of Electronic Health Records in Saudi Arabia: An Ethereum-Based Framework for Enhanced Security and Patient Control. International Journal of Advanced Computer Science and Applications [Internet]. 2024 Jan 1 [cited 2025 Aug 30];15(4). Available from: https://thesai.org/Publications/ViewPaper?Volume=15&Issue=4&Code=IJACSA&SerialNo=112
21. Alfazzi F. Roadmap to Smart Cities in Saudi Arabia: Key Challenges and Opportunities. Deleted Journal. 2024 Apr 4;20(3s):2248–59.
22. Saudi Arabia Market Research. Q2 Sees 51% Rise in Blockchain Registrations [Internet]. Saudi Market Research | Consulting Firm. 2025. Available from: https://saudimarketresearchconsulting.com/insights/articles/saudi-blockchain-registrations-hit-4-005-in-q2
23. IMARC Group. Saudi Arabia Blockchain Market Size, Share & Growth 2033 [Internet]. Imarcgroup.com. 2024. Available from: https://www.imarcgroup.com/saudi-arabia-blockchain-market
24. Kumar K. Saudi Arabia Blockchain Market Overview Market Size in 2024: USD 0.23 Billion Market Size in 2033: USD 35. [Internet]. Linkedin.com. 2025. Available from: https://www.linkedin.com/pulse/saudi-arabia-blockchain-market-growth-research-report-kishan-kumar-hb6yc
25. Alshareef N, Tunio MN. Role of Leadership in Adoption of Blockchain Technology in Small and Medium Enterprises in Saudi Arabia. Frontiers in Psychology. 2022 May 4;13.

26. Aldaarmi AAA. Digital transformation in SME financing in Saudi Arabia: Leveraging digital financial intermediation to overcome challenges, maximize benefits, and foster sectoral growth. International Journal of Innovative Research and Scientific Studies. 2025 Mar 7;8(2):517–30.
27. Omar M. Integrating smart contracts into the legal framework of Saudi Arabia. International Journal of Law and Management. 2024 May 15;
28. Qatran YA. The Feasibility of Implementing Blockchain Technology in Islamic Financial Engineering Products at Islamic Banks in Saudi Arabia: A Case Study of Al Rajhi Bank [Internet]. Wordpress.com. 2025 [cited 2025 Aug 31]. Available from: https://internationalcenter689408158.wordpress.com/the-feasibility-of-implementing-blockchain-technology-in-islamic-financial-engineering-products-at-islamic-banks-in-saudi-arabia-a-case-study-of-al-rajhi-bank/
29. Alshahrani SM. Enabling blockchain for Saudi Arabia drug supply chain using Internet of Things (IoT). PeerJ Computer Science [Internet]. 2024 May 22;10:e2072. Available from: https://peerj.com/articles/cs-2072/#
30. Al-Subaie H, ageeli othman. The role of medical records management in activating knowledge management applications in private hospitals in Saudi Arabia. Arab International Journal of Knowledge Managment. 2024;3(3):97–160.
31. Mutahhar AY, Khanzada TJS, Shahid MF. Analyzing critical success factors using blockchain based framework for intelligent transportation systems. Frontiers in Blockchain. 2025 Jan 3;7.
32. Alkhodre A, Ali T, Jan S, Alsaawy Y, Khusro S, Yasar M. A Blockchain-based Value Added Tax (VAT) System: Saudi Arabia as a Use-Case. International Journal of Advanced Computer Science and Applications. 2019;10(5).
33. Hajr L, Katamoura S, Mirza A. Bitcoin Cryptocurrency and Electronic Commerce in Saudi Arabia. SAGE Open. 2023 Oct 1;13(4).
34. Alsaadi AH, Bamasoud DM. Blockchain Technology in Education System A Survey Examining Potential Uses of Blockchain in Saudi Arabia Education. (IJACSA) International Journal of Advanced Computer Science and Applications. 2021;12(5).
35. Obidallah WJ, Rashideh W, Kamaruddeen AM, Alzahrani T, Alduraywish Y, Alsahli A, et al. Beyond the Hype: A TAM-Based Analysis of Blockchain Adoption Drivers in Construction Industry. Heliyon. 2024 Sep 1;e38522–2.