

-RESEARCH ARTICLE-

## TRENDS IN BLOCKCHAIN TECHNOLOGY APPLICATION IN THE GULF

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### —Abstract—

Blockchain technology represents a transformative innovation within the Fourth Industrial Revolution, offering significant potential to enhance transparency, security, and operational efficiency across multiple sectors. This study investigates current trends in the adoption and implementation of blockchain within the Arab world, with a focus on countries of the Gulf Cooperation Council (GCC). The research methodology relies on a comprehensive review of scholarly literature, official governmental reports, and documented initiatives, employing qualitative descriptive and comparative approaches to evaluate institutional readiness, regulatory frameworks, and practical applications of blockchain technology in the region. The study further examines the deployment of blockchain by governments and financial institutions in GCC countries to optimise business operations, improve public service delivery, and enhance economic outcomes, while also situating regional experiences in the context of global best practices. Findings indicate that several Gulf nations, including Bahrain, the United Arab Emirates, and the Kingdom of Saudi Arabia, possess advanced digital infrastructures and strategic initiatives that facilitate blockchain adoption. These efforts reflect a growing recognition of blockchain as a strategic component of digital infrastructure that aligns with national development objectives and long-term planning agendas. Nevertheless, despite these advancements, blockchain integration in the Gulf remains at an initial stage. The expansion of blockchain applications is constrained by regulatory ambiguity, limited inter-institutional coordination, legal barriers, and the scarcity of specialised human resources. In conclusion, while blockchain technology offers substantial opportunities to improve transparency, trust, and efficiency in both public and private sector operations, fully realising these benefits will necessitate more comprehensive

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regulatory frameworks, strengthened governance structures, and sustained capacity-building measures across GCC countries.

**Keywords:** Blockchain Technology; Financial Technology (FinTech); Digital Transformation; Gulf Cooperation Council (GCC); Regulatory Frameworks; Institutional Readiness.

## INTRODUCTION

Digital Transformation in the Economy and Administration: The digital transformation of contemporary economic and administrative systems has been driven by the rapid advancement of information and communication technologies. These developments have led governments, businesses, and institutions to increasingly rely on digital tools to enhance efficiency, elevate service standards, and support sustainable development. The acceleration of digital transformation has been further facilitated by innovations associated with the Fourth Industrial Revolution, including artificial intelligence, the Internet of Things, cloud computing, and blockchain technology (Buckley et al., 2023; Treiblmaier et al., 2020). Blockchain technology has attracted widespread international attention due to its capacity to establish secure, transparent, and decentralised systems for recording and validating transactions. In contrast to traditional centralised frameworks, blockchain enables direct peer-to-peer interactions, thereby reducing the need for intermediaries, lowering transaction costs, and improving both trust and data integrity. Beyond its technical characteristics, blockchain is increasingly regarded as a strategic digital infrastructure with the potential to transform economic, financial, and institutional processes (Muzammal et al., 2019; Nakamoto, 2008).

While often associated with digital currencies, blockchain technology has diverse applications across governance, finance, and commerce. These include digital identity management, public record systems, cross-border payment solutions, supply-chain tracking, and smart contract platforms (Buckley et al., 2023; Cagigas et al., 2021). Consequently, blockchain has become a central component of many countries' digital transformation strategies, particularly for those aiming to modernise public services and enhance competitiveness within the global digital economy. In the Arab world, especially among GCC countries, interest in blockchain continues to expand as part of broader strategies to strengthen economies, improve governance, and promote innovation-driven development. Gulf nations have invested extensively in digital infrastructure and e-government initiatives, creating an enabling environment for new technological adoption. National development plans, including long-term strategic frameworks, have further highlighted blockchain as a tool for enhancing efficiency, transparency, and institutional performance (Schulz et al., 2020).

Despite these favourable conditions, the adoption of blockchain technology across GCC countries remains uneven and largely confined to pilot projects and experimental

initiatives (Ducas & Wilner, 2017). Some countries exhibit advanced preparedness through legislative reforms and coordinated institutional efforts, whereas others remain cautious due to legal ambiguities, institutional limitations, and concerns regarding data security and the availability of specialised human resources. This variability underscores the need for a systematic assessment of blockchain adoption trends, institutional readiness, and practical applications within the Gulf region. The present study aims to examine current trends in the adoption and implementation of blockchain technology in GCC countries, focusing on institutional preparedness, regulatory frameworks, and key application areas. Additionally, it provides a comparative perspective to evaluate whether regional adoption aligns with or diverges from global best practices.

This study is structured as follows: Section 2 outlines the methodology employed for data collection and evaluation. Section 3 presents a detailed conceptual framework of blockchain technology, defining its core elements, categories, and principal characteristics. Section 4 reviews global applications and trends in blockchain adoption. Section 5 assesses the use of blockchain technology in GCC countries, with emphasis on regulatory preparedness, current initiatives, and comparative analysis. Section 6 summarises the findings and examines their implications, and Section 7 concludes the study with recommendations.

## RESEARCH METHOD

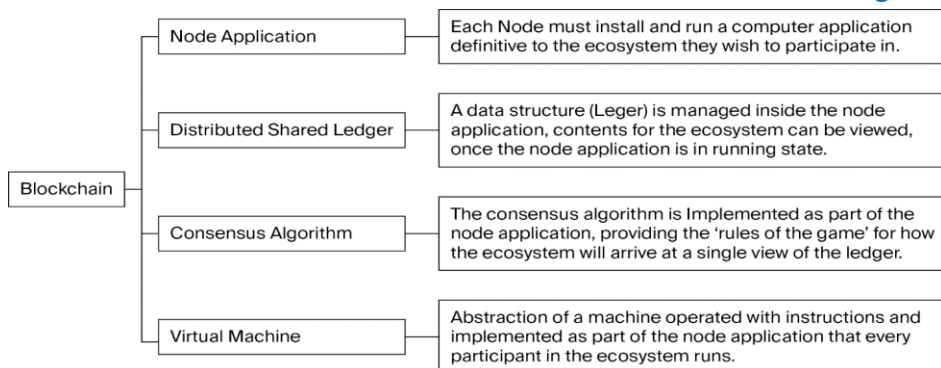
This study employs a qualitative descriptive and comparative methodology to examine prevailing trends in the adoption and implementation of blockchain technology within GCC countries. This methodological design was chosen to provide a systematic understanding of how blockchain is applied across governmental, financial, and institutional contexts, and to evaluate the region's readiness for wider deployment of the technology. The descriptive component involves a thorough review and synthesis of existing academic literature, international reports, policy documents, and official publications concerning blockchain technology and digital transformation. This approach facilitates the identification of core concepts, primary application domains, and common challenges associated with blockchain adoption at both regional and global levels (De Filippi et al., 2020). The analysis prioritises documented initiatives and practical use cases over hypothetical or experimental applications.

Complementing this, a comparative approach is adopted to identify similarities and differences between blockchain adoption practices in GCC countries and those in other global regions. This comparison considers regulatory frameworks, institutional coordination, strategic national initiatives, and sector-specific applications, thereby enabling an assessment of the GCC's position within the international blockchain landscape. Data sources for the analysis are exclusively secondary, comprising peer-

reviewed academic studies, reports from international organisations, governmental publications, and policy-oriented documents. Sources were selected for their relevance, credibility, and contribution to understanding trends in blockchain adoption and associated regulatory developments. No primary data collection instruments, such as surveys or interviews, were employed. Collectively, this methodological framework provides a structured and objective foundation for analysing blockchain technology adoption in the Gulf region and offers a coherent basis for interpreting findings, discussing implications, and outlining future research directions in subsequent sections of this study.

## CONCEPTUAL FRAMEWORK OF BLOCKCHAIN TECHNOLOGY

Blockchain technology constitutes a decentralised digital ledger that records transactions across distributed network nodes in a secure, transparent, and tamper-resistant manner. By facilitating peer-to-peer validation through cryptographic consensus mechanisms, blockchain reduces dependence on centralised intermediaries and strengthens trust among diverse stakeholders. Blockchain networks are generally classified as public, private, or consortium, based on governance models and access permissions (Mathis, 2018; Singhal et al., 2018). Public blockchains permit open participation, whereas private and consortium blockchains limit validation rights to authorised entities, rendering them more appropriate for institutional and governmental contexts. From an institutional standpoint, the primary significance of blockchain lies in its capacity to enhance transparency, improve auditability, lower operational costs, and automate processes via programmable smart contracts (Bodó et al., 2018). Nonetheless, widespread adoption remains limited due to regulatory ambiguity, scalability challenges, and the requirement for specialised technical expertise (Esmaili & Christensen, 2025; König et al., 2020). Given these attributes, blockchain is increasingly recognised not merely as a technical advancement but as a strategic digital infrastructure capable of supporting public administration, financial systems, and inter-organisational collaboration. Consequently, the subsequent sections focus on global institutional applications and regulatory developments pertinent to GCC countries rather than on the technical architecture, as illustrated in Figure 1.



**Figure 1:** Basic Elements of a Blockchain System Architecture

During the early 2000s, a central challenge in the digital economy was addressing the “double-spending problem,” which arose when attempting to create a purely digital currency without reliance on a central clearinghouse. Validating transactions was not feasible without a trusted intermediary. Blockchain technology, in conjunction with peer-to-peer (P2P) networks (Muzammal et al., 2019), resolves this issue by eliminating the need for centralisation. Within this framework, all participants, or “peers,” maintain equal status in managing the ledger through distributed nodes. By employing cryptographic techniques and distributed consensus protocols, blockchain systems can securely and accurately verify ledger states. This mechanism effectively replicates the functions of a central clearinghouse while operating within a decentralised network where no single entity exercises control (Esmaili & Christensen, 2025; Nakamoto, 2008).

Cryptography is central to blockchain systems, enabling secure transaction verification and rendering unauthorised modification or forgery virtually impossible. Validation is performed by nodes, which operate independently to confirm transactions and blocks in accordance with predefined consensus rules. In public, permission less blockchains, such as Bitcoin, any participant with sufficient computational resources may operate a node and partake in transaction validation, thereby reinforcing decentralisation and transparency (Esmaili & Christensen, 2025). Consequently, blockchain is widely acknowledged as a reliable and innovative framework for digital transformation (Mathis, 2018; Nakamoto, 2008; Singhal et al., 2018). It mitigates risks of data manipulation and unauthorised record alteration by ensuring that transaction information is securely recorded and cryptographically protected across distributed nodes. This structure establishes a robust system for secure information storage and transaction processing without dependence on central intermediaries.

Each blockchain transaction follows a sequence of structured steps to guarantee validity, security, and permanence. These steps encompass transaction initiation, network broadcasting, validation via consensus mechanisms, block creation, and integration into the existing blockchain ledger. Figure 4 depicts the operational workflow of blockchain, illustrating the process by which transactions are verified and added to the ledger in a tamper-resistant and transparent manner (Chowdhury et al., 2021). In practice, a blockchain transaction begins with user-level authentication, where transaction details are initiated and verified. The transaction data are then compiled into a block and broadcast to all participating nodes within the network. Each node independently checks the block by comparing its contents against existing records on the distributed ledger. Blocks containing inaccurate or tampered data are rejected by the network. If nodes reach consensus on the transaction’s validity, the block is approved and appended to the blockchain. Once added, the updated ledger is synchronised across all nodes, ensuring both immutability and transparency. In systems employing the Proof of Work mechanism, nodes that successfully validate

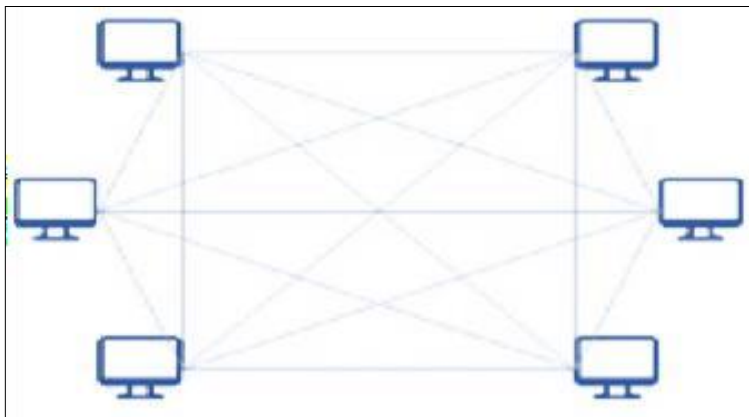
and add blocks receive cryptocurrency rewards, providing an economic incentive for maintaining network security and integrity (Esmaili & Christensen, 2025; Nakamoto, 2008).

### Terms Related to the Concept of Blockchain

Several fundamental terms and classifications are associated with blockchain technology, reflecting the range of its applications and governance structures. Blockchain networks are commonly divided into three primary types: public blockchains, private blockchains, and consortium (or alliance) blockchains. Each category exhibits specific characteristics and functions within distinct structural and administrative frameworks (Esmaili & Christensen, 2025; Nakamoto, 2008). Consortium blockchains occupy an intermediate position between public and private models. Unlike private blockchains, which are controlled by a single central authority, consortium blockchains are governed by a select group of organisations or stakeholders. The distinguishing features, governance models, and typical applications of public, private, and consortium blockchains are summarised in Table 1.

### Public Blockchains

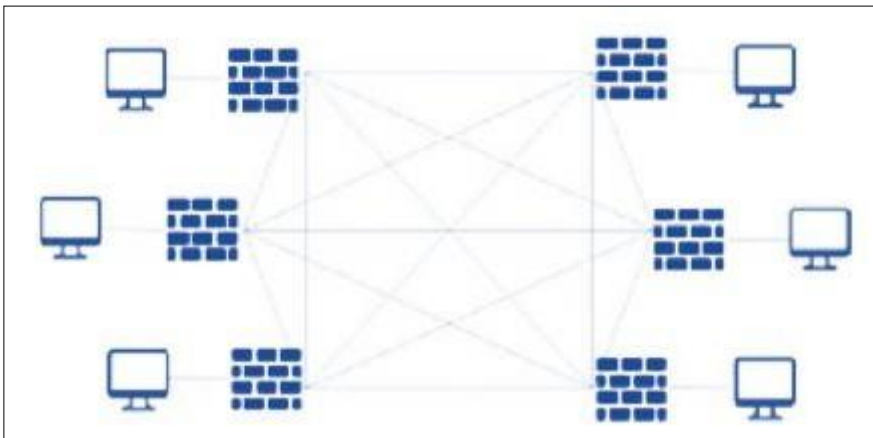
Public blockchains are open-source, permission less networks that permit any individual to participate, irrespective of geographic location or nationality. Their fully decentralised architecture operates without a central authority, which can complicate regulatory supervision. These networks commonly utilise native digital tokens or cryptocurrencies to incentivise participants who engage in transaction validation and support the maintenance of the network. Figure 2 presents the operational structure of a public blockchain network (Muzammal et al., 2019). Figure 2 depicts the operational mechanism of a public blockchain network, emphasising its open-access architecture, the decentralised validation process, and the function of distributed nodes in preserving the integrity of the shared ledger.



**Figure 2:** Operational Structure of a Public Blockchain Network

## Private Blockchains

Private blockchains are permissioned networks in which only authorised entities are allowed to participate. A node can join the blockchain solely after receiving approval from a designated controlling authority. This governance model enables strict access control and management of data, rendering private blockchains more centralised compared with public blockchain networks. These blockchains are commonly implemented by organisations aiming to collaborate and exchange data securely while safeguarding sensitive business information from public networks. Such systems are particularly prevalent in enterprise environments where regulatory compliance, data security, and controlled access are essential. [Figure 3](#) illustrates the operational framework of a private blockchain, showing how restricted access and centralised governance are implemented within this network type.

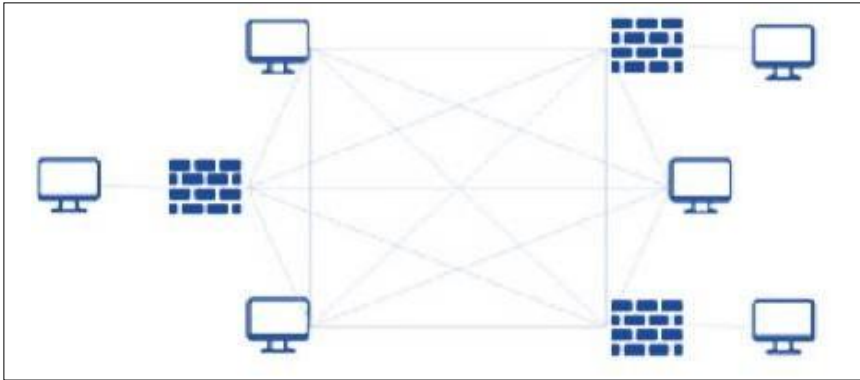


**Figure 3:** Private Blockchain Network

## Private Blockchains

Private blockchains are permissioned networks in which participation is limited to authorised nodes. A node may join the network only after receiving approval from a controlling authority. This governance structure allows for strict access management and centralised oversight of data permissions, making private blockchains more centralised than public counterparts. In contrast to public blockchains, private blockchains generally do not use native digital tokens or cryptocurrencies to motivate participation. Instead, transaction validation and network maintenance are performed by trusted entities within the organisation or consortium. Consequently, private blockchains are particularly suited for organisations seeking to collaborate and share information securely without exposing sensitive business data on a public, permissionless network. Private blockchain systems are widely employed in enterprise settings where confidentiality, regulatory compliance, and operational efficiency are essential. [Figure 3](#) illustrates the operational framework of a private blockchain, highlighting

how access control and transaction validation are managed within a restricted network (Muzammal et al., 2019).



**Figure 4:** Operational Structure of a Consortium Blockchain Network

Figure 4 depicts the operational model of a consortium blockchain, in which transaction validation and governance responsibilities are distributed among a selected group of participating organisations rather than being controlled by a single central authority or an open public network. Consortium blockchains represent a hybrid governance approach, combining characteristics of both public and private blockchain networks. As blockchain technology remains relatively nascent and continues to evolve, its implementation practices are subject to ongoing refinement. This evolving nature has given rise to technical, social, and political challenges that may constrain large-scale adoption in certain contexts. A key strategy for addressing these challenges is to tailor blockchain deployment according to functional and organisational requirements. By choosing among public, private, and consortium blockchain models, institutions can design solutions that meet specific needs regarding decentralisation, privacy, governance, cost efficiency, and transaction throughput. This adaptable approach has proven effective in progressively mitigating many obstacles associated with blockchain adoption (Esmaili & Christensen, 2025; Muzammal et al., 2019; Nakamoto, 2008). Table 1 presents a comparative overview of the primary differences and advantages of public, private, and consortium blockchains. It illustrates how each type operates within a distinct structural and governance framework and serves diverse application contexts, thereby providing organisations with options to adopt blockchain technology in a manner that balances innovation, regulatory compliance, and operational effectiveness (Esmaili & Christensen, 2025). Table 1 provides a comparative summary of public, private, and consortium blockchains, emphasising their structural distinctions, operational features, and principal advantages.

**Table 1: Differences and Advantages of Public, Private, and Consortium Blockchains**

Item	Public Blockchains	Private Blockchains	Consortium Blockchains
Key Features	Open and permission less networks with high decentralization; generally associated with higher operational costs and lower privacy levels	Permissioned networks offering higher efficiency, controlled access, enhanced privacy, and faster transaction processing with reduced data duplication	Collaborative blockchain networks managed by a group of organizations, combining decentralization with controlled access, enhanced security, and lower operational costs
Transaction Confirmation Time	Long	Short	Short
Energy Consumption	High energy consumption	Lower energy consumption	Lower energy consumption
Participants	Open to all participants without restrictions	Participants are determined and authorized by a central entity	Limited to pre-selected alliance members
Level of Decentralization	Fully decentralized with no intermediary required to validate transactions	Centralized or semi-centralized	Partially decentralized and shared among consortium members
Practical Applications	Bitcoin and other public cryptocurrencies	Internal clearing and settlement systems	Financial reviews, inter-organizational transactions, and shared business platforms

### Advantages of Using Blockchain in Transactions

The concept of blockchain technology has progressed beyond its initial role in individual financial transactions to encompass broader applications within large-scale projects and institutional systems. It is increasingly utilised as a dependable mechanism for recording, verifying, and securing data, while also improving liquidity and operational efficiency in both financial and non-financial transactions. These capabilities have established blockchain as a foundational digital infrastructure capable of supporting complex transactional environments (Mathis, 2018). Blockchain introduces a novel protocol architecture that minimises dependence on intermediaries, enhances scalability, and allows for the direct transfer of value without censorship, corruption, or excessive centralisation. Consequently, it has garnered considerable attention across multiple sectors, including finance, government services, supply chains, and digital platforms (Muzammal et al., 2019; Woodhall, 2018). The significance of blockchain extends beyond its technical design to its potential for transforming economic and social systems. By enabling decentralised and transparent mechanisms of trust, blockchain provides innovative methods for organising transactions and interactions within business networks and society more broadly

(Singhal et al., 2018). Recent technological advancements have accelerated the deployment and adoption of blockchain systems (Buckley et al., 2023; Treiblmaier et al., 2020), reinforcing their role as a key driver of digital transformation (Esmaili & Christensen, 2025; Nakamoto, 2008). Blockchain promotes trust within transactional networks through a set of core features that strengthen transparency, security, and accountability, as outlined below.

### **Distribution**

The distributed ledger is maintained collaboratively and updated continuously across all nodes within the blockchain network. Transactions are recorded in real time without dependence on a central server, ensuring both data accessibility and system robustness.

### **Decentralization**

Blockchain systems function on decentralised databases in which replicated data are distributed across public or permissioned ledgers accessible to all interconnected network participants. This arrangement enables collaboration among parties while substantially mitigating the risk of data loss, unauthorised alteration, or system failure.

### **Security**

Blockchain networks utilise advanced cryptographic methods and permission-based access controls to safeguard against unauthorised manipulation of data. Successfully altering transaction records would require compromising a majority of network nodes simultaneously, rendering such attacks highly impractical and reinforcing system security.

### **Transparency**

Since every node maintains a copy of the ledger, all authorised participants can access transaction records and independently verify their authenticity without the intervention of intermediaries.

### **Consensus**

The validity of transactions is ensured through consensus mechanisms, which require agreement among network participants prior to the addition of new records to the blockchain. These protocols guarantee accuracy, consistency, and trust across the decentralised network.

### **Flexibility**

Blockchain platforms incorporate programmable logic via smart contracts, which

automatically execute pre-defined conditions. This functionality enables blockchain systems to evolve alongside business processes and adapt to shifting operational requirements.

### **Speed and Cost Efficiency**

By removing central settlement authorities and the need for third-party verification, blockchain transactions can be executed more rapidly and at lower cost. Participants can exchange assets directly, reducing operational complexity and administrative overhead (Muzammal et al., 2019).

Beyond these benefits, blockchain technology provides a technical solution to persistent challenges concerning trust, coordination, and pluralism within complex systems. Effectively addressing these challenges requires ongoing collaboration among governments, civil society, academia, non-governmental organisations, and international institutions, including entities such as the United Nations (Alsubaei, 2019; Sobrinho et al., 2019). Despite its considerable advantages, blockchain technology is not entirely without risk, particularly in financial contexts. However, these risks are generally considered limited relative to the substantial benefits of blockchain-based systems, especially when supported by appropriate regulatory frameworks and governance mechanisms.

## **GLOBAL APPLICATIONS OF BLOCKCHAIN TECHNOLOGY**

Blockchain technology has progressed from a specialised innovation to a fundamental digital infrastructure that underpins a wide array of applications across diverse sectors. Its worldwide adoption demonstrates increasing recognition of its capacity to improve transparency, security, efficiency, and trust within complex transactional and data-driven systems. This section provides an overview of the most notable global applications of blockchain technology, emphasising institutional and sector-specific use cases.

### **Major Sectors Adopting Blockchain Technology Globally**

A key domain of blockchain adoption is government and public sector services. Governments across the globe are increasingly deploying blockchain to enhance public record management, strengthen administrative transparency, and mitigate fraud (Cagigas et al., 2021). Typical applications include digital identity management, land and property registries, licensing systems, and secure document verification. Such implementations contribute to more efficient service delivery and higher levels of public trust. The financial services sector continues to be a primary adopter of blockchain. Financial institutions utilise blockchain to enable cross-border payments, optimise settlement procedures, and enhance compliance through transparent, auditable transaction records. Blockchain systems reduce both transaction times and

associated costs while improving security and traceability, particularly in interbank transfers and trade finance operations (Casey et al., 2018; Chowdhury et al., 2021). Supply chain and logistics management constitutes another major area of blockchain deployment. Blockchain facilitates real-time monitoring of goods across complex supply networks, enhancing traceability, accountability, and product authenticity. These applications are especially relevant in sectors such as food safety, pharmaceuticals, and international trade (Chang et al., 2019; Dewey et al., 2018; Härting et al., 2017).

### **Global Trends in Blockchain Adoption and Investment**

At the global scale, blockchain adoption has been propelled by both public and private sector efforts aimed at modernising digital infrastructure. While early investments were largely concentrated on cryptocurrency-related applications, recent developments indicate a shift towards enterprise and government-driven blockchain solutions, focusing on practical value creation rather than speculative uses. Governments and international organisations have increasingly explored regulatory frameworks and pilot programmes to support blockchain integration in public services and financial systems. Simultaneously, private sector entities continue to invest in blockchain platforms to enhance operational efficiency, data security, and cross-organisational collaboration. Despite this growing interest, global blockchain adoption remains uneven. Many countries continue to rely on pilot initiatives and controlled experiments due to regulatory ambiguities, technical challenges, and concerns over scalability and governance. Consequently, worldwide blockchain deployment is best understood as being in a transitional stage, moving from experimentation toward large-scale institutional implementation.

Figure 5 depicts the rapid growth in global expenditure on blockchain technology applications, reflecting the accelerating adoption of blockchain across multiple economic sectors. The global market value of blockchain technology has expanded significantly over a relatively short timeframe. Estimates suggest that spending on blockchain-related initiatives rose from approximately USD 228 million in 2016 to an anticipated USD 5.34 billion by 2023, corresponding to a compound annual growth rate of nearly 57.6%. This swift increase underscores the growing perception of blockchain as a strategic technology with applications extending well beyond digital currencies. Figure 5 illustrates a continuous upward trajectory in global blockchain-related expenditures through 2022, demonstrating sustained investment momentum and rising confidence among governments, financial institutions, and private sector entities. The spiral-like growth pattern reflects not only higher adoption rates but also the widening range of blockchain applications across diverse industries (Statista).



Figure 6 illustrates the primary sectors adopting blockchain technology globally, demonstrating the wide-ranging applications of blockchain across public, financial, technological, and industrial domains.

**Table 2: Blockchain Application Domains and Their Sub-Elements across Key Sectors**

Main Element	Sub-Elements
GOVERNMENT	• Record storing system• Secure data sharing• Transparent public services• Fraud prevention
IDENTIFICATION	• User identification• Digital identity• Blockchain-based ID systems
MOBILE PAYMENTS	• Digital payments• Faster transactions• Reduced fees
INSURANCE	• Smart contracts• Claims processing• Fraud reduction
ENDANGERED SPECIES PROTECTION	• Tracking animals• Preventing illegal trade
CARBON OFFSETS	• Emission tracking• Carbon credit trading
INTEROPERABILITY	• Blockchain data exchange• Cross-platform integration
ACCESS CONTROL	• Identity-based access• Secure permissions
SUPPLY CHAINS	• Product tracking• Provenance verification• Transparency
HEALTHCARE	• Medical records• Secure patient data• Data sharing
SHIPPING	• Cargo tracking• Documentation automation
REAL ESTATE	• Property records• Ownership transfer
ENERGY	• Energy trading• Smart grids• Consumption tracking
LAND REGISTRY	• Land ownership• Secure records
JOURNALISM	• Content verification• Fake news prevention
COMPUTATION	• Distributed computing• Secure data processing
ADVERTISING	• Ad verification• Transparency• Fraud prevention
BORDER CONTROL	• Secure identity• Travel records
DATA MANAGEMENT	• Data ownership• Secure storage
ECONOMY	• Digital currencies• Financial inclusion
TAXATION	• Tax collection• Transparent reporting
BRIDGES	• Energy conversion• Infrastructure management
BUSINESS	• Process automation• Transparency
ENTREPRENEURSHIP	• Start-up funding• Decentralized platforms
NATIONAL SECURITY	• Secure data• Intelligence sharing
MUSIC	• Copyright protection• Royalties distribution
TOURISM	• Travel records• Booking systems
FISHING	• Supply tracking• Sustainability

### Sectors that Embrace Blockchain

In Table 2, Blockchain technology has been integrated across numerous sectors due to its capacity to enhance transparency, security, efficiency, and trust within transactional and data-intensive environments. The subsections below outline the principal sectors adopting blockchain globally.

## **Government and Institutional Services**

Blockchain provides substantial benefits to government and institutional operations by improving the speed, reliability, and transparency of service delivery. Governments can employ blockchain to issue and verify official documents, including birth, death, marriage, and divorce certificates, academic credentials, driver's licenses, and national identity cards. Additionally, blockchain supports secure data verification, distribution of government subsidies, digital voting in national elections, and registration of private property such as land, real estate, and vehicles. These applications bolster public trust while reducing administrative inefficiencies and opportunities for fraud (Singhal et al., 2018).

## **Financial Services**

The financial services sector remains a primary beneficiary of blockchain integration. Blockchain-enabled systems operate continuously, avoiding disruptions caused by limited banking hours or weekends. Transaction processing is significantly expedited, as validation and recording on the blockchain typically require only a few minutes. This efficiency streamlines settlement processes, lowers operational costs, and increases overall reliability of financial transactions (Casey et al., 2018).

## **Healthcare**

Healthcare information is highly sensitive, demanding accuracy, security, and privacy. Blockchain offers a secure framework for storing and sharing patient records among healthcare providers, insurers, and authorised stakeholders. By encrypting medical data and managing access permissions, blockchain ensures data integrity, protects patient privacy, and mitigates the risk of data loss or unauthorised modifications (Sayal & Jha, 2023).

## **Smart Contracts**

Smart contracts are among the most widely implemented blockchain applications. These digital agreements operate according to predefined conditions established by the involved parties. Once the criteria are met, the contract terms are executed automatically without intermediaries. Smart contracts facilitate verification, negotiation, and enforcement while reducing costs, delays, and reliance on third-party brokers (Bodó et al., 2018; Fridgen et al., 2018).

## **Delivery and Supply Chain Management**

Blockchain enables the creation of more transparent, efficient, and secure supply chains by providing reliable tracking of goods and transactions across complex networks. All relevant stakeholders—including producers, buyers, and regulators—

can access verified records documenting each stage of the supply chain. This transparency allows consumers to verify product authenticity, ethical sourcing, and safety through time-stamped data, such as tracing food from production to consumption (Härting et al., 2017).

### **Intellectual Property Protection**

In the digital era, the ease of copying and distributing content has weakened creators' ability to safeguard intellectual property rights. Blockchain, especially when paired with smart contracts, provides effective solutions for copyright protection, automated licensing, and digital rights management. These mechanisms reduce fraud, unauthorised copying, and illegal distribution, while enabling creators to sell their works directly to consumers via automated and transparent processes (Fridgen et al., 2018).

### **Banking Institutions**

Banks utilise blockchain to share transaction information, monitor fund flows, and detect suspicious activities across interconnected systems. Blockchain also supports the re-engineering of banking operations by removing traditional settlement processes, enabling faster and more secure transactions. Applications include securities settlement, trade finance, commercial real estate transactions, and cross-border payments (Casey et al., 2018)(Civelek & Özalp, 2018).

### **Identity Management**

The expansion of online transactions and e-commerce has increased demand for secure identity verification systems. Blockchain enhances identity management by digitising personal documents, strengthening authentication protocols, and giving users greater control over their personal data. This approach facilitates secure participation in digital platforms and mitigates identity fraud in online transactions (Buckley et al., 2023; Nakamoto, 2008).

### **Data Management and Analysis**

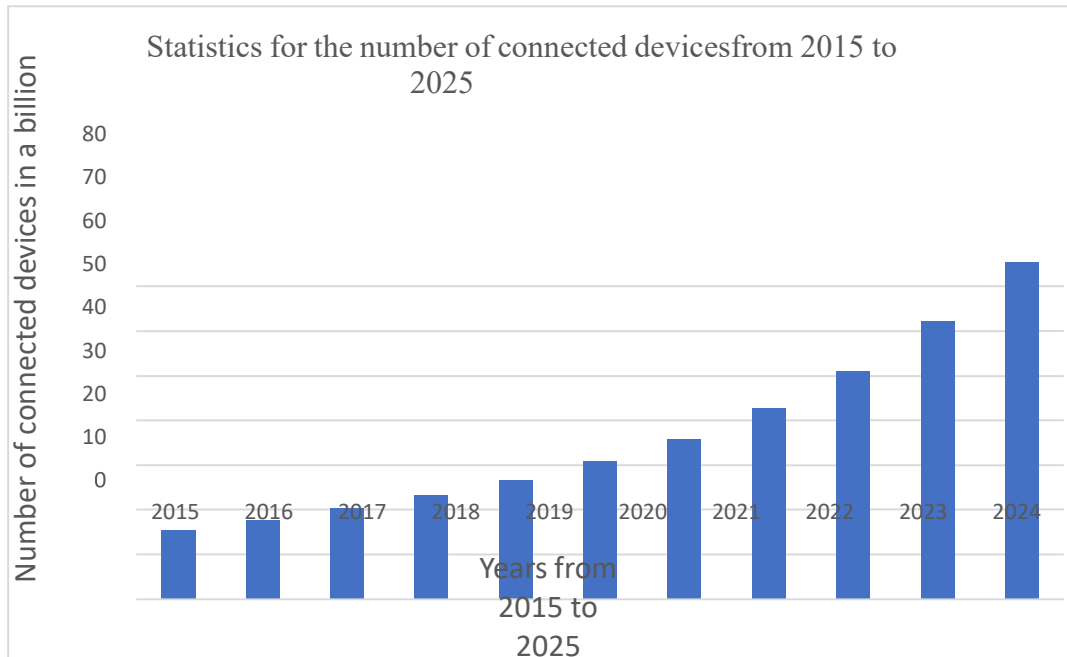
Blockchain functions as a decentralised data storage solution supporting both static and dynamic data. Static data are immutable and permanently recorded on the blockchain, whereas dynamic data are generated with each new transaction. When static blockchain data are combined with analytics platforms, organisations can derive insights into transaction patterns, trends, and predictive indicators. Analysing dynamic data enables real-time monitoring of blockchain activity, allowing prompt detection of fraudulent behaviour and prevention of unauthorised transactions (De Filippi et al., 2020; Esmaili & Christensen, 2025; Nakamoto, 2008). Future developments may also

allow individuals to control and monetise their personal data, with digital currencies such as Bitcoin potentially serving as instruments for data-based transactions.

### The Internet of Things (IoT)

The IoT is a network of physical devices equipped with sensors, software, and connectivity that allows them to communicate and exchange data over the internet (Dewey et al., 2018; Pinto et al., 2020). The number of connected devices rose from approximately 15.41 billion in 2015 to 23.14 billion in 2018, with projections exceeding 75 billion devices in coming years (Statista., 2021). Figure 7 illustrates the growth of connected IoT devices from 2015 to 2025. Integrating blockchain with IoT enhances security, data integrity, and trust by enabling decentralised device authentication and secure data exchange across interconnected systems.

Figure 7 illustrates the exponential growth in the number of Internet of Things (IoT) connected devices worldwide from 2015 to 2025. The data reveal a consistent upward trajectory, with connected devices rising from approximately 15.41 billion in 2015 to 23.14 billion in 2018. Projections indicate this figure could surpass 75 billion devices by 2025, underscoring the rapid global proliferation of IoT technologies and the consequent importance of integrating blockchain solutions to ensure secure and reliable device communication (Statista., 2021).



**Figure 7:** Statistics for the Number of Connected Devices from 2015 to 2025

**Source:** Statista, “IoT: Number of Connected Devices Worldwide 2015–2025,” Statista Research Department (Statista., 2021).

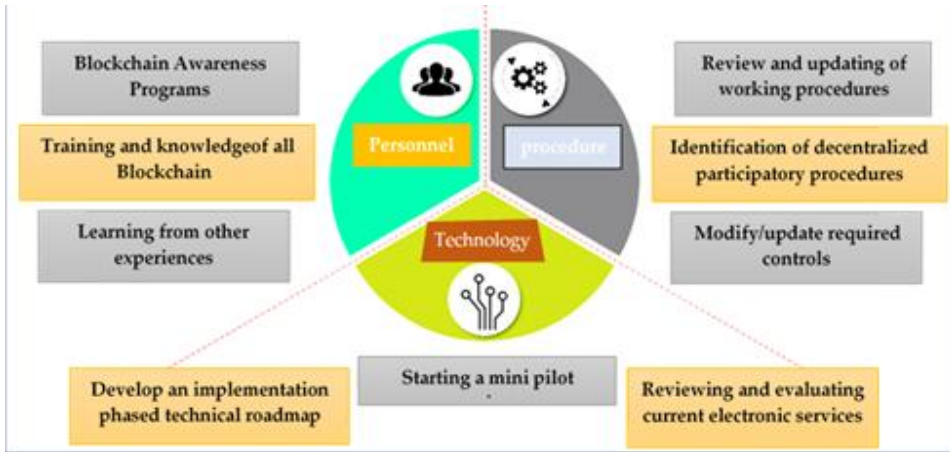
The Internet of Things (IoT) is a virtual network connecting a diverse array of physical objects embedded with electronics, software, sensors, and actuators, all linked via the internet. This interconnectivity allows these devices to communicate and exchange data in real time (Dewey et al., 2018). Although the IoT may seem conceptually simple, it is highly complex in practice and difficult to define succinctly. Technically, it involves the collection of vast quantities of data generated by connected devices, followed by analysis to identify patterns and predict future behaviours. This process relies on multiple communication protocols, data-processing frameworks, and programming languages. Proponents of the IoT envisage a future where most electronic devices operate autonomously, with minimal or no human intervention. Smart devices are expected to monitor their own performance, detect potential issues, and in some instances, resolve problems independently. As IoT applications expand, their scope now includes both anticipated and unanticipated use cases, and the technology is expected to extend far beyond basic daily-life applications in the coming years (Dewey et al., 2018). Whether through lowering operational costs, improving safety and automation, or enhancing workforce efficiency, the IoT is widely recognised as a critical driver of business growth. It is considered one of the most transformative technological advancements since the creation of the internet, fundamentally reshaping human-device interactions and enabling seamless integration between smart technologies and the physical environment.

### **The Shift Towards Blockchain**

Blockchain applications, like conventional software systems, are deployed via decentralised architectures designed to support secure economic and financial environments. These systems aim to strengthen security, build trust, and manage digital assets through incentive-based mechanisms that typically reward network participants, such as miners, for contributing computational resources and validating transactions (König et al., 2020). Figure 8 highlights the primary factors to consider in transitioning to blockchain technology, including human-related considerations, the technological infrastructure employed, and procedural frameworks required to ensure an effective and sustainable transformation process (Alshareef, 2022).

Figure 8 outlines the key factors that organisations should address when transitioning to blockchain technology, including considerations related to human resources, technological infrastructure, and procedural and regulatory frameworks. An increasing number of institutions are exploring the adoption of tailored blockchain models that extend beyond cryptocurrency-focused use cases. In 2018, the financial sector accounted for over 60% of the global blockchain market value, highlighting its early and intensive uptake within financial services (Buckley et al., 2023; Treiblmaier et al., 2020). However, blockchain applications have since expanded into government operations, despite their historically centralised and bureaucratic structures.

Governments are leveraging blockchain to improve inter-agency coordination, reduce fraud and administrative errors, and cut costs associated with paper-based and manual processes (Buckley et al., 2023; Cagigas et al., 2021).



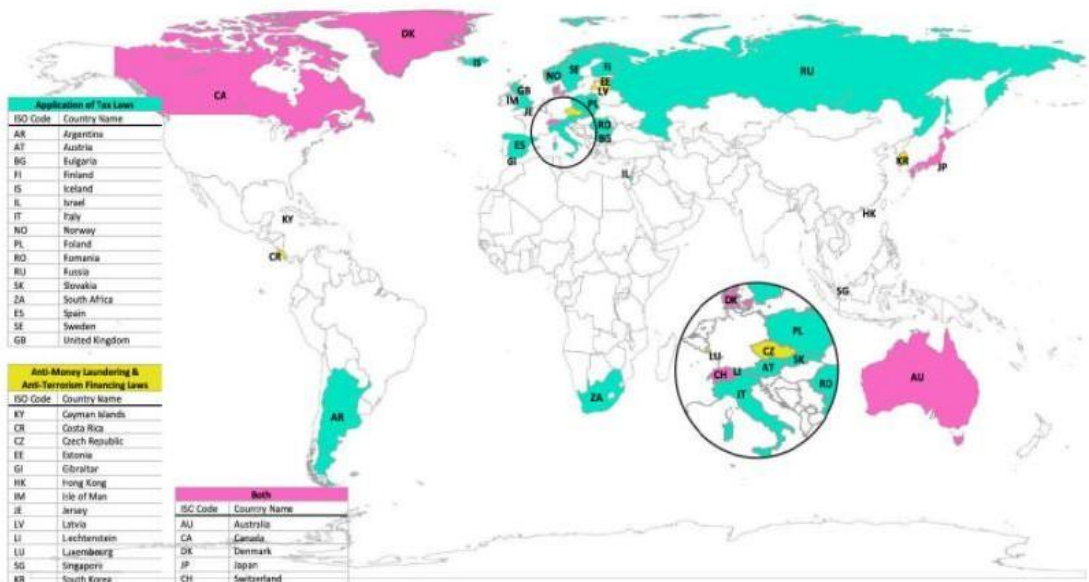
**Figure 8:** Key Axes for the Transition toward Blockchain Technology

Expectations for blockchain have grown to the point where some analysts suggest it may eventually transform or partially replace certain traditional government functions. The decentralised architecture of blockchain enables seamless interaction among all network participants, including human users and smart devices within the IoT. This structure supports data and value exchange without reliance on a central authority. Despite its transformative promise, blockchain remains at an early developmental stage. Widespread implementation is projected to require an additional three to five years to address existing technical, organisational, and regulatory challenges. Consequently, nearly half of institutions maintain a cautious approach, favouring observation and experimentation over full deployment (Esmaili & Christensen, 2025; König et al., 2020).

Market-driven enhancements in blockchain solutions are increasingly apparent, backed by investments in pilot programs, testing environments, and demonstration projects. These initiatives aim to transition gradually from experimental applications to large-scale operational systems. Simultaneously, major technology firms and manufacturers of smart and autonomous systems, including self-driving vehicles, have engaged in developing technical standards, piloting projects, and contributing to open-source blockchain platforms since 2019, resulting in steady technological progress. In addition, numerous multinational corporations, including Fortune 500 companies across insurance, finance, retail, and manufacturing sectors, have begun implementing both experimental and operational blockchain-based services. This reflects a growing recognition of blockchain's capacity to improve operational efficiency, transparency, and trust within complex business environments.

## Implementation Challenges in Blockchain Technology and Bitcoin

Blockchain technology was originally introduced as a pioneering innovation through Bitcoin, the first decentralised digital system. Designed to facilitate peer-to-peer internet transactions without conventional banking intermediaries, Bitcoin provided the foundation for broader blockchain adoption (Nakamoto, 2008). The subsequent emergence of numerous other cryptocurrencies stimulated further interest in decentralised digital assets. A notable milestone occurred with the launch of Ethereum in 2014, whose rapid market growth by 2017 drove investment and innovation within the blockchain ecosystem (George et al., 2019; Mathis, 2018). This surge in adoption led to the creation of hundreds of blockchain-focused enterprises and the allocation of billions of dollars in global investments. While some initiatives achieved commercial viability, others fell short of expectations. Nonetheless, multinational organisations—particularly in banking (Civelek & Özalp, 2018), insurance, and healthcare—have identified practical blockchain use cases, supported by ongoing research and real-world experimentation. Consequently, discourse regarding blockchain's potentially revolutionary impact has extended beyond technical circles to a broader audience in business and the public sphere. In certain instances, blockchain has been portrayed as a universal solution to diverse economic and organisational challenges, enhancing its prominence within both technology and business domains (Alsakhnini & Almoaiad, 2024; Casey et al., 2018).



### Regulatory Framework for Cryptocurrencies:

Application of Tax Laws, Anti-Money Laundering/Anti-Terrorism Financing Laws, or Both



**Figure 9:** Application of Taxation, Anti-Money Laundering, and Counter-Terrorism Laws to the Circulation of Digital Currencies Worldwide

One of the most pressing challenges in adopting cryptocurrencies concerns taxation and regulatory classification. The key issue is defining cryptocurrencies and related activities within legal frameworks to determine the appropriate tax policies, akin to those applied to conventional profit-generating enterprises (Fyrigou-Koulouri, 2018). This complexity is compounded by the fact that cryptocurrencies are not issued or regulated by sovereign authorities, creating public debate and regulatory uncertainty in multiple jurisdictions (Irina, 2018). If revenues from cryptocurrency mining or trading are deemed income or capital gains, corresponding tax rates must be applied. Figure 9 illustrates the varied approaches adopted by countries worldwide regarding digital currency regulation, encompassing taxation, anti-money laundering measures, and counter-terrorism financing rules related to cryptocurrency circulation.

Figure 9 demonstrates the approaches adopted by various countries in regulating digital currencies, including taxation frameworks, anti-money laundering compliance, and counter-terrorism financing measures governing the issuance and circulation of cryptocurrencies.

### **Classification inside the Figure 9**

#### **No Regulation of Cryptocurrencies**

- ✓ Afghanistan
- ✓ Algeria
- ✓ Bolivia
- ✓ Ecuador
- ✓ Iceland
- ✓ Iran
- ✓ Morocco
- ✓ Nepal
- ✓ Pakistan
- ✓ Saudi Arabia

#### **Anti-Money Laundering Laws Only**

- ✓ Canada
- ✓ Germany
- ✓ United Kingdom
- ✓ United States

#### **Tax Laws Only**

- ✓ Australia
- ✓ Denmark
- ✓ Finland

- ✓ Japan
- ✓ South Korea

### **Both Tax Laws and Anti-Money Laundering/Anti-Terrorism Financing Laws**

- ✓ Austria
- ✓ Belgium
- ✓ Brazil
- ✓ China
- ✓ Czech Republic
- ✓ France
- ✓ Greece
- ✓ Hungary
- ✓ Italy
- ✓ Japan
- ✓ Luxembourg
- ✓ Netherlands
- ✓ Poland
- ✓ Portugal
- ✓ Singapore
- ✓ Spain
- ✓ Sweden

### **Map Labels/Abbreviations Appearing on the Map**

- ✓ US (United States)
- ✓ CA (Canada)
- ✓ BR (Brazil)
- ✓ RU (Russia)
- ✓ CN (China)
- ✓ JP (Japan)
- ✓ KR (South Korea)
- ✓ AU (Australia)
- ✓ ZA (South Africa)
- ✓ MX (Mexico)

At the international level, only a select few countries—such as the United States, Switzerland, and Mexico—have formally recognised cryptocurrencies as a valid medium of payment, with some even permitting their use by government agencies alongside national currencies (Ibrahim & Truby, 2022; Pantin, 2023). Despite these developments, the use of cryptocurrencies for official or widespread transactional purposes remains limited in comparison with traditional financial systems, which rely on banks as central intermediaries for processing transactions (Casey et al., 2018).

This cautious stance is largely due to persistent concerns regarding financial stability, regulatory oversight, and adherence to existing legal and institutional frameworks. As a result, most nations continue to prioritise conventional banking technologies while progressively examining regulatory models that could integrate digital currencies in controlled and supervised settings. [Figure 10](#) depicts the number of countries that allow or engage in the domestic circulation of digital currencies, illustrating the diverse levels of acceptance and regulatory involvement across different regions.



**Figure 10:** Countries Involved in the Internal Circulation of Digital Currencies Worldwide

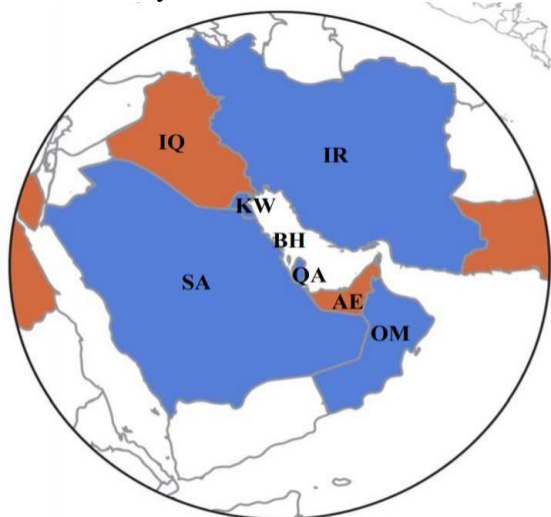
[Figure 10](#) illustrates the worldwide distribution of countries that allow or participate in the domestic circulation of digital currencies, highlighting differences in regulatory acceptance and legal recognition across regions which can be seen in [Table 3](#).

**Table 3: Classification of Countries for Digital Currencies**

ISO Code	Country Name
AI	Anguilla (ECCB)
AG	Antigua and Barbuda (ECCB)
CN	China
DM	Dominica (ECCB)
GD	Grenada (ECCB)
IE	Ireland
LT	Lithuania
MH	Marshall Islands
KN	Saint Kitts and Nevis (ECCB)
LC	Saint Lucia (ECCB)
VC	Saint Vincent and the Grenadines (ECCB)
VE	Venezuela

Within the Arab region, governmental attitudes toward digital currencies exhibit significant variation, spanning from cautious endorsement to outright prohibition. Available evidence suggests that adoption of digital currencies by Arab governments remains among the lowest globally. This limited uptake is primarily influenced by considerations related to compliance with Islamic law, as well as concerns over financial stability, consumer protection, and regulatory oversight. Consequently, regulatory approaches across many Arab states have generally been conservative, even as interest in blockchain technology continues to grow. While certain countries in the region have implemented selective blockchain initiatives—particularly in domains such as digital identity management, government services, and trade facilitation—others maintain strict restrictions on the use of digital currencies. Figure 11 presents the regulatory positions of Arab countries regarding digital currencies. Jurisdictions marked in red enforce an absolute prohibition, whereas those depicted in blue indicate an implicit ban, reflecting a spectrum of regulatory stringency across the region.

Figure 11 provides a regional overview of Arab countries, illustrating their regulatory positions on digital currencies. The maps above summarise findings from international reports concerning the legal status of cryptocurrencies and the regulatory frameworks governing their use. These frameworks constitute a tangible aspect of blockchain technology and must be carefully considered when implementing blockchain-based systems. Despite the potential advantages offered by blockchain, several challenges continue to limit its widespread adoption, including concerns about user privacy and identity protection, high implementation costs, and apprehensions regarding the integration of an emerging technology within financial and transactional environments. These obstacles largely stem from the relative novelty of blockchain technology in global transaction systems.



**Figure 11:** Map of Arab Countries and their Position on Digital Currencies

## BLOCKCHAIN ADOPTION AMONG GULF COOPERATION COUNCIL (GCC) COUNTRIES

This section explores the implementation of blockchain technology within the Gulf Cooperation Council (GCC) countries, emphasising regulatory preparedness, institutional frameworks, and current deployment initiatives. The discussion highlights both commonalities and differences among GCC nations while contextualising regional developments against global practices.

### Regulatory and Institutional Readiness in GCC Countries

GCC countries have exhibited a comparatively high level of preparedness for adopting emerging digital technologies, driven by sustained investment in information and communication technology infrastructure and the expansion of e-government platforms. National digital transformation strategies and long-term development plans have been instrumental in shaping institutional readiness for blockchain implementation. Regulatory strategies across the GCC demonstrate variation in scope and maturity. Certain countries have prioritised the establishment of comprehensive legal and regulatory frameworks to manage blockchain applications, particularly in financial services and digital transaction environments. These frameworks are designed to foster innovation while mitigating risk, addressing areas such as data protection, cybersecurity, and adherence to existing financial regulations. Conversely, other GCC nations have taken a more cautious and experimental stance, often relying on pilot programmes to evaluate blockchain applications. [Table 4](#) classifies blockchain projects based on sectoral emphasis and the degree of international adoption.

**Table 4: Government Blockchain Projects by Field and Level of Global Prevalence**

No.	Field	Number of Projects	International Prevalence
1	Strategy, Research, and Standards	51	Very High (50 and Above)
2	Personal Records	25	High (20–49)
3	Identity (Credentials, Attestations, Licenses)	25	High (20–49)
4	Economic Development	23	High (20–49)
5	Financial Services	20	High (20–49)
6	Land Title and Registry	19	Medium (10–19)
7	Central Bank Digital Currencies (CBDCs)	19	Medium (10–19)
8	Benefits and Entitlements	13	Medium (10–19)
9	Compliance and Reporting	12	Medium (10–19)
10	Trade and Supply Chain Management	10	Medium (10–19)
11	Voting and Elections	7	Low (9 or Less)
12	New Products and Services	7	Low (9 or Less)
13	Payments	6	Low (9 or Less)
14	Asset Registry	6	Low (9 or Less)

15	Public Transport	6	Low (9 or Less)
16	Data Marketplace and Data Monetization	6	Low (9 or Less)
17	General Infrastructure and Public Records	6	Low (9 or Less)
18	Public Utilities	5	Low (9 or Less)
19	Regulatory Applications	4	Low (9 or Less)
20	Tax Collection and Credits	4	Low (9 or Less)
21	Government Finance	4	Low (9 or Less)
22	Cybersecurity (Critical Infrastructure)	3	Low (9 or Less)
23	Legal Enforcement and Courts	3	Low (9 or Less)
24	Military and Defence Infrastructure	2	Low (9 or Less)
25	Digital Tokens	2	Low (9 or Less)
26	Internet of Things (IoT)	1	Low (9 or Less)

Source: (Alsubaei, 2019).

Table 4 categorizes government blockchain initiatives according to their application domains and the degree of international dissemination. Analysis of Table 4 indicates that research-focused and academic blockchain initiatives represent the most widely implemented category globally, marked in red. These projects primarily aim to establish theoretical frameworks, develop technical standards, and generate foundational knowledge that facilitates broader blockchain adoption. Applied blockchain initiatives constitute the second most prevalent category, highlighted in blue. These projects span practical sectors such as management and storage of personal data records, issuance and verification of property deeds, economic development programmes, public service delivery, and financial operations. The prominence of these initiatives reflects the increasing interest in leveraging blockchain to enhance operational efficiency, transparency, and trust in real-world applications.

Moderately prevalent projects, shown in yellow, are concentrated in areas including land registry management and central bank digital currencies. While these applications hold considerable potential, their wider adoption is limited by regulatory, technical, and institutional constraints that hinder large-scale deployment. The least common projects, represented in green, cover over fifteen diverse areas, including electoral and voting systems, public utilities, transportation infrastructure, legislative and judicial institutions, credit mechanisms, and tax collection systems. The restrained adoption in these sectors illustrates the cautious approach governments take when implementing emerging technologies in highly sensitive or mission-critical functions (Alsubaei, 2019; H, 2019).

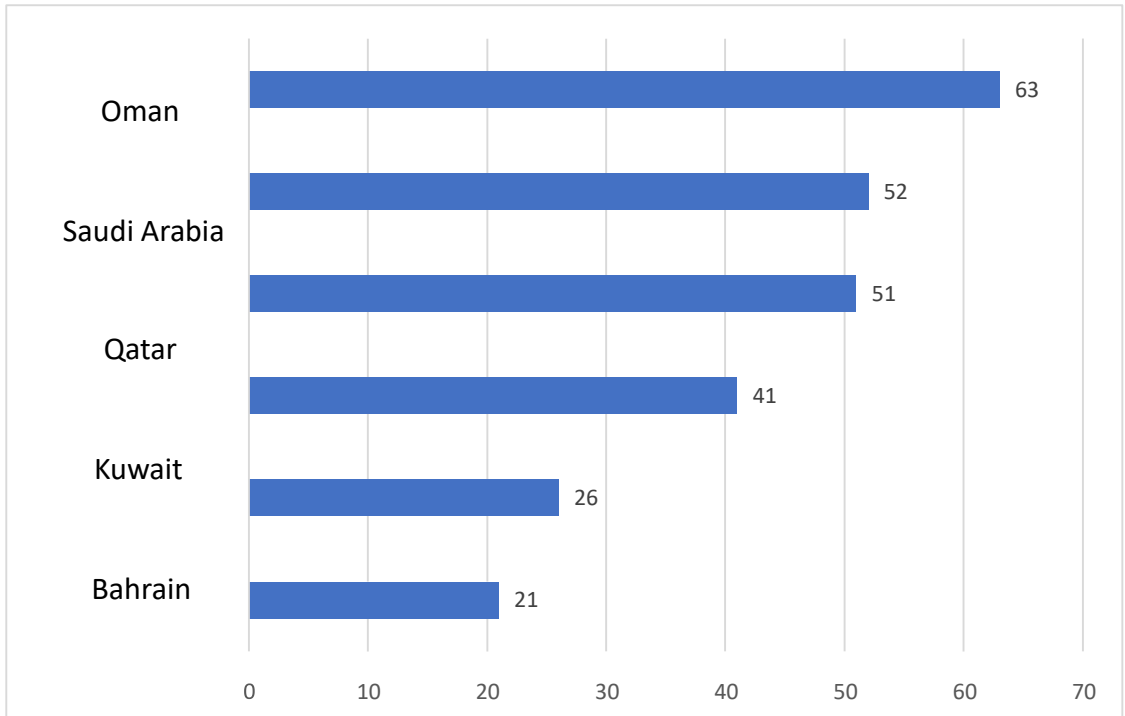
## BLOCKCHAIN ADOPTION IN THE GULF COOPERATION COUNCIL (GCC)

This section examines blockchain adoption in the Gulf Cooperation Council (GCC) countries, focusing on regulatory preparedness, institutional frameworks, and practical

implementation initiatives. The analysis highlights national strategies for blockchain integration while identifying shared regional patterns and challenges.

### Regulatory and Institutional Readiness in GCC Countries

GCC nations have demonstrated relatively advanced institutional readiness for blockchain adoption, supported by sophisticated digital infrastructure, extensive e-government initiatives, and national digital transformation strategies. Long-term development plans have been pivotal in embedding emerging technologies within public sector reform and economic diversification agendas. Regulatory preparedness, however, varies across the GCC. Some countries have prioritised the creation of legal and supervisory frameworks to regulate blockchain applications, particularly in financial services, digital identity systems, and electronic transactions. These frameworks are designed to promote innovation while managing risk, addressing issues such as data protection, cybersecurity, and regulatory compliance. Other GCC states have taken a more cautious approach, relying on pilot programmes and regulatory sandboxes to evaluate blockchain solutions before enacting comprehensive legislation. Overall, the GCC regulatory environment reflects a gradual and controlled transition toward blockchain adoption, prioritising institutional coordination and policy alignment over rapid, large-scale implementation.



**Figure 12:** Ranking of GCC Countries According to EGDI

## **Current Blockchain Initiatives in GCC Countries**

### **Bahrain**

Bahrain has positioned itself as one of the most proactive GCC nations in establishing a regulatory environment supportive of blockchain adoption. The country has prioritised the creation of legal frameworks and regulatory guidelines before pursuing large-scale implementation, particularly in the domains of financial services and digital documentation. Regulatory authorities have introduced sandbox environments to facilitate controlled experimentation with blockchain-based financial products and services. Blockchain initiatives in Bahrain have mainly targeted government services, financial transactions, and digital record management. These efforts reflect an institutional focus on regulatory clarity and compliance, establishing Bahrain as a regional centre for blockchain governance and financial innovation ([Alsakhnini & Almoaiad, 2024](#); [Alsubaei, 2019](#)).

### **Kingdom of Saudi Arabia**

Saudi Arabia has implemented a strategic and application-oriented approach to blockchain, closely aligned with national development goals and digital transformation agendas. The Kingdom's blockchain adoption has concentrated on logistics, customs operations, financial services, and cross-border transactions, demonstrating its objective of enhancing efficiency and transparency within large-scale economic systems. Regulatory authorities have facilitated blockchain experimentation through fintech initiatives and pilot programmes, particularly in banking and payments. Saudi Arabia's approach stresses practical value creation and integration with existing institutional frameworks rather than rapid decentralization, reinforcing blockchain's function as an enabling technology within broader digital ecosystems ([Alsakhnini & Almoaiad, 2024](#); [Alshareef, 2022](#); [Alsubaei, 2019](#)).

### **United Arab Emirates**

The United Arab Emirates is recognised as a regional leader in blockchain adoption, especially within government services. Both national and emirate-level strategies have explicitly incorporated blockchain as a key component of digital transformation, aiming to streamline public services and reduce administrative costs. UAE blockchain initiatives span multiple sectors, including government transactions, transportation, financial services, and digital identity management. Emphasis on inter-agency coordination and public-private partnerships has facilitated the integration of blockchain platforms into operational workflows. This proactive stance positions the UAE at the forefront of institutional blockchain implementation in the GCC ([Alsakhnini & Almoaiad, 2024](#); [Alsubaei, 2019](#)).

## Other GCC Countries

Other GCC states have shown growing interest in blockchain technology, though adoption remains largely experimental and limited. Initiatives are primarily focused on financial services, digital payments, and selected government applications. Regulatory authorities generally adopt cautious approaches, prioritising risk assessment and gradual implementation. Although widespread deployment remains limited, ongoing pilot projects and strategic planning indicate increasing awareness of blockchain's potential advantages. These countries are expected to expand their blockchain use as regulatory frameworks mature and institutional capabilities strengthen.

## Comparative Analysis: GCC Countries and Global Practices

Relative to global trends, blockchain adoption in GCC countries reflects a pragmatic, institutionally oriented model. Unlike regions where adoption is primarily driven by private sector experimentation or decentralised innovation, GCC countries prioritise government-led initiatives, regulatory oversight, and alignment with national development strategies (Alsubaei, 2019). While global blockchain adoption is largely in a transitional stage, GCC countries exhibit comparatively strong digital readiness and centralised coordination. Nevertheless, adoption rates remain consistent with global patterns, as large-scale implementation continues to be limited. Factors such as regulatory uncertainty, governance constraints, and human capital limitations influence adoption pace both regionally and internationally (Ibrahim & Truby, 2022). Overall, GCC nations demonstrate a balanced approach that emphasises stability, compliance, and strategic alignment, mitigating long-term risks associated with emerging technologies while gradually enabling innovative deployment.

Table 5 summarizes blockchain projects announced by the Gulf countries between 2016 and 2019, organized by sector (Alsubaei, 2019).

**Table 5: Summary of Current Projects in the Field of Blockchain**

Sector	Completed Initiatives	Piloting/Implementation Phase	Under Review
Government	- Bahrain enacted legislation regulating the use of blockchain platforms and digital asset exchanges.	- Emirates Blockchain Strategy 2021. - National Blockchain Adoption Strategy (Bahrain Economic Development Board). - Deployment of blockchain platforms in customs operations at maritime ports in coordination with private sector partners.	- Provision of select government services using blockchain technology (UAE and KSA).
Finance and Banking	- Central banks and monetary authorities authorized and integrated	- Validation of customer data for banking services using Know Your Customer (KYC)	- Joint Saudi–Emirati digital currency for interbank transfers.

	<p>blockchain platforms within banking alliances.</p> <ul style="list-style-type: none"> <li>- Central Bank of Bahrain issued draft regulations for crypto-assets and launched a regulatory sandbox to test blockchain-based products and systems.</li> <li>- Use of blockchain platforms for money transfers and banking and securities transactions.</li> <li>- Licensing of companies to exchange virtual currencies (UAE).</li> </ul>	mechanisms.	<ul style="list-style-type: none"> <li>- Revision of laws and regulations governing virtual transactions.</li> <li>- Commercial deployment of blockchain platforms for digital payments.</li> </ul>
Education	- Training programs focused on blockchain systems and applications.	- Issuance of university degrees using blockchain technology (Bahrain and UAE).	-

## DISCUSSION

This study investigated global patterns of blockchain technology adoption, with particular attention to the Gulf Cooperation Council (GCC) countries. The findings demonstrate that blockchain has progressed from a niche technological concept to a strategic digital infrastructure capable of enabling institutional transformation across both public and private sectors. Evidence indicates that blockchain adoption has expanded beyond experimental or cryptocurrency-focused applications and is increasingly integrated into government services, financial systems, and large-scale economic operations (Buckley et al., 2023; Cagigas et al., 2021; Treiblmaier et al., 2020). The analysis shows that GCC countries possess comparatively high levels of digital and institutional readiness relative to many developing regions. This preparedness is largely driven by sustained investment in digital infrastructure, the growth of e-government platforms, and the embedding of emerging technologies within national development strategies. Nations such as Bahrain, the United Arab Emirates, and Saudi Arabia have exhibited a strategic understanding of blockchain's potential to enhance transparency, operational efficiency, and trust in institutional processes (Alsakhnini & Almoaiad, 2024; Alsubaei, 2019).

Despite these favourable conditions, blockchain adoption across the GCC remains predominantly limited to pilot projects and controlled implementations. This pattern mirrors global trends, where broad deployment is constrained by regulatory uncertainty, governance challenges, scalability limitations, and the requirement for specialised human capital. The GCC case illustrates that technological capability alone does not guarantee successful blockchain adoption; instead, robust governance frameworks, clear legal provisions, and coordinated cross-institutional efforts are essential for sustainable implementation. Moreover, the government-led and

regulation-focused approach adopted by GCC countries may serve to reduce long-term risks associated with emerging technologies. Although this model may decelerate short-term rollout, it offers a structured pathway for embedding blockchain into sensitive sectors such as finance, public administration, and national infrastructure. As such, the GCC experience exemplifies a cautious yet strategic progression from experimentation toward institutionalised adoption.

## **CONCLUSION AND RECOMMENDATIONS**

### **Conclusion**

This study examined global trends in blockchain technology adoption, with particular focus on the GCC countries, emphasising regulatory preparedness, institutional structures, and sector-specific applications. The analysis highlights blockchain technology's considerable potential to improve transparency, operational efficiency, and trust across both public and private sector environments. Within the GCC, blockchain adoption benefits from advanced digital infrastructure and comprehensive national development agendas. Despite this supportive environment, implementation largely remains at an early stage, characterised by pilot projects and controlled initiatives rather than full-scale deployment. Ongoing challenges—including regulatory uncertainty, governance complexities, limited institutional coordination, and the need for specialised human capital—continue to influence the pace and extent of adoption. In conclusion, blockchain technology should be regarded as a strategic, long-term investment rather than a short-term technical fix. Its effective integration into institutional systems requires harmonising technological innovation with regulatory frameworks, organisational capabilities, and overarching socio-economic objectives.

### **Recommendations**

Based on the outcomes of this study, the following recommendations are proposed.

#### **Regulatory Recommendations**

GCC countries should prioritise the development of comprehensive and flexible legal frameworks to govern blockchain applications across various sectors. Establishing clear regulatory standards can minimise uncertainty, foster private sector engagement, and stimulate innovation while safeguarding data privacy, cybersecurity, and financial system stability.

#### **Institutional Recommendations**

Governments and public institutions should enhance inter-agency coordination and establish dedicated bodies or task forces to supervise blockchain initiatives. Aligning

blockchain projects with existing digital transformation strategies can improve integration, reduce duplication, and ensure more coherent implementation.

### Capacity-Building Recommendations

Sustainable adoption of blockchain technology requires significant investment in human capital. Expanding specialised training programs, incorporating blockchain-focused content into academic curricula, and fostering public-private partnerships can cultivate the technical, legal, and managerial expertise necessary for effective blockchain deployment.

### Future Research Recommendations

Subsequent research should examine the practical outcomes of blockchain implementation in GCC countries, including cost-benefit evaluations, performance assessments, and sector-specific impact analyses. Comparative studies across regions can further elucidate best practices and inform evidence-based policy development.

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