BLOCKCHAIN ADOPTION IN THE GULF STATES

DR. FATIMA ALSUBAEI

IN ASSOCIATION WITH THE BAHRAIN CENTER FOR STRATEGIC

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CONTENTS

SUMMARY

Blockchain technology is regarded as a key component of the fourth industrial revolution with wide-ranging potential applications in everything from healthcare and financial services to transportation and intellectual property rights. This research paper seeks to shed light on the use of blockchain technology in the Gulf states by analyzing current trends of blockchain adoption in the region compared to those internationally. In so doing, this study will determine Gulf institutions' capacity for keeping pace with the changes and developments introduced by the adoption of blockchain.

Cover photo: A visual representation of Bitcoin is displayed on Dec. 22, 2017 in Paris, France. (*Photo by Chesnot/Getty Images*)

Above photo: A site manager checks mining equipment inside a bitcoin mine near Kongyuxiang, Sichuan, China. (*Photo by Paul Ratje/For The Washington Post via Getty Images*)

Photo spread on pages 11-12: Bitcoins in Ankara, Turkey on January 04, 2018. (*Photo by Mehmet Ali Ozcan/Anadolu Agency/Getty Images*)

INTRODUCTION

The subject of extensive international interest and attention over the past few years, blockchain technology is regarded as a key component of the fourth industrial revolution that has helped change the structure of the global economy while increasing opportunities for development, innovation, and an improved quality of life. Accordingly, this research paper seeks to shed light on use of blockchain technology in the Gulf states by analyzing current trends of blockchain adoption in the region compared to those internationally. In so doing, the study will determine Gulf institutions' capacity for keeping pace with the changes and developments blockchain adoption has introduced. It will also touch on the expansion of operational procedures and service provision in various economic and government sectors around the globe.

PREFACE

Although significant progress has been made in various fields as a result of the digital transformation, the recent emergence of revolutionary technologies like the Internet of Things, artificial intelligence, cloud computing, blockchain, and 3D printing has given rise to a number of new developments affecting the government, business, and industrial sectors alike.

These innovations have received extensive international attention due to the structural changes they have introduced to the global economy and their ability to enhance development and improve people's lives. Growing international demand for smart applications and communications networks, big data, and more advanced cybersecurity technology has also increased their popularity.

The importance of these new technologies and their influential role in future development processes requires thorough planning, given their considerable potential for creating new opportunities to modernize operational processes, enhance the quality of services, and support innovation and competitiveness across all economic sectors. In turn, this requires researching these technologies to better understand how they operate, the concepts involved, how to benefit from their developmental potential, and the new laws that must be enacted to safely enable their adoption.

In particular, this paper seeks to shed light on blockchain, a key technology and component of the fourth industrial revolution that will greatly impact most sectors and change human life, while analyzing its current adoption and usage in the Gulf states.

PART 1: THE CONCEPT AND DEVELOPMENT OF BLOCKCHAIN TECHNOLOGY

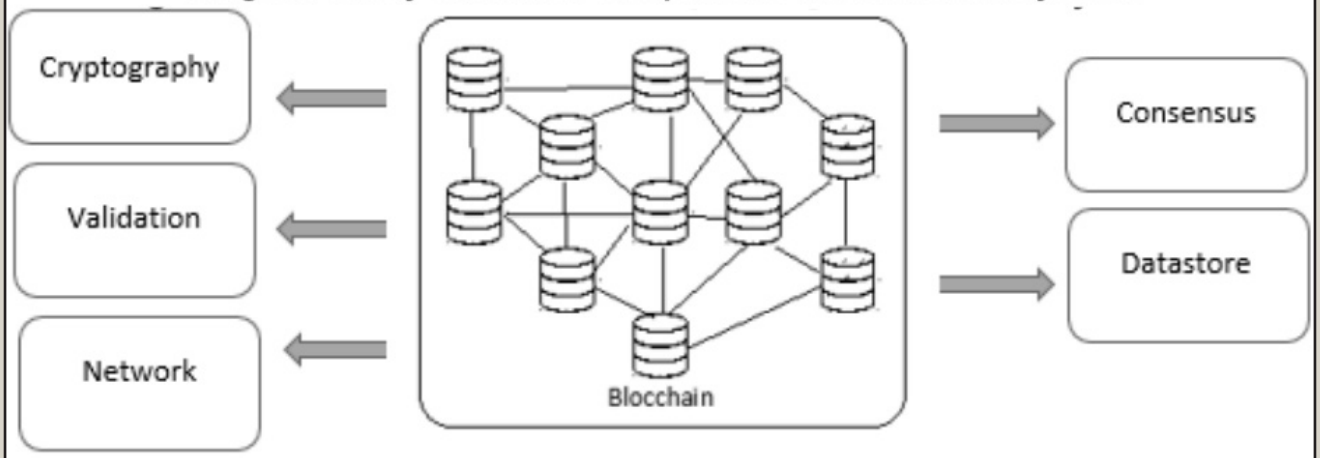
The word "blockchain" first appeared in a paper titled "Bitcoin: A Peer-to-Peer Electronic Cash System" published by a pseudonymous individual or group known as "Satoshi Nakamoto" in 2008. The term was first applied to the core underlying component of "Bitcoin" digital currency that is discussed in this paper.

Today, blockchain is used as a general term for all applications and systems utilizing a distributed public ledger, which enables secure and direct transactions to be completed without requiring the system to have a particular controlling authority. Blockchain technology can thus be defined as an encrypted information system built upon a decentralized database distributed throughout an entire network apparatus that records all transactions and transaction modifications, in turn ensuring that all parties have access to valid data.

Blockchain's high degree of decentralization and transparency are its two primary strengths. These figure in all types of transactions, including payments and bank transfers, managing property ownership and national identification records, transferring assets and documents, voting, and more.

Blockchain systems allow parties to complete exchanges without relying upon third-party mediators like banks to execute transactions and ensure trust and security. (*Photo by Robert Wallis/Corbis via Getty Images*)

Diagram 1: Key Structural Components of Blockchain Systems



Source: Muzammal, M., Qu., Q., & Nasrulin, B. (2019).

Blockchain's decentralized method of building and storing data differs from traditional databases (see Diagram 1). Blockchain is distributed across all devices linked to a network, known as "nodes." These datapoints are then validated and represented in accordance with specific consensus rules. Unlike data in centralized databases, blockchain data is preserved in a unified transaction ledger and displayed as an identical copy of the data that all other interconnected devices can access. The ledger contains a continuously updated list of transactions called "blocks" that are bound together by uniquely identifiable and encrypted "hash-values." These protect confidentiality and data validity using algorithms including consensus rules like "proof of work," "proof of concept," "proof of ownership," "digital signature," "public/private key infrastructure encryption," and so on.

The decentralized nature of the blockchain allows any two parties to exchange any two values over a peer-to-peer network. This removes the need for a central mediating authority like a financial institution to administer the transaction system. This peer-to-peer network allows all relevant parties and entities to access the system at any time; validate the source and origin of each transaction; record each transaction's data and bring into a state of consensus; and confirm that each involved party has verified the transaction via a process known as "mining." Once all parties approve the transaction, a "block" composed of a "header" and "body" is then created and linked to the chain of remaining blocks in the network (see Diagram 2).

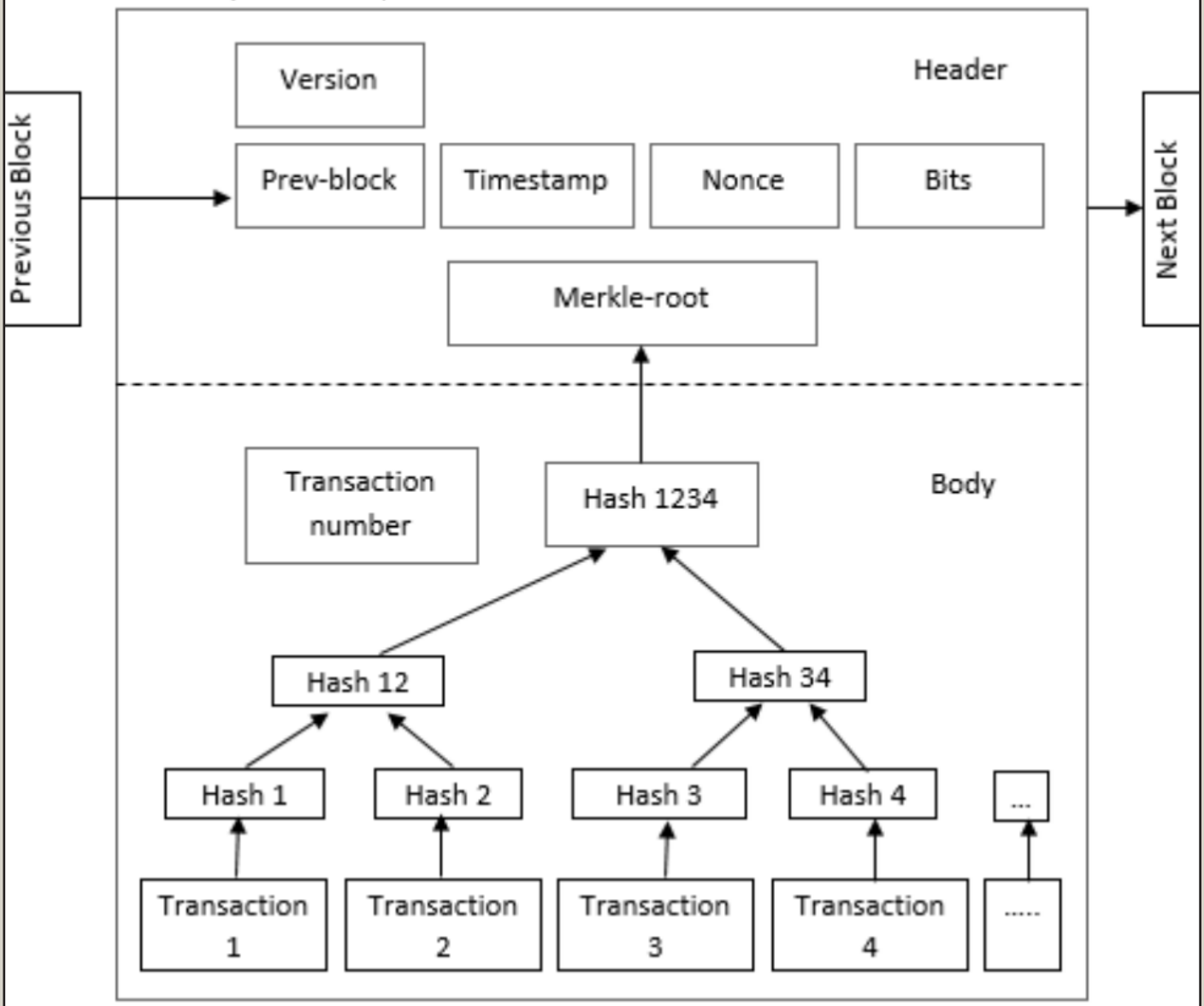
Blockchain technology ensures a high degree of transaction trust, transparency, and security by providing users with comprehensive data and the ability to review the historical record of all datapoints, transactions, and attendant

changes. A transaction can only be deleted if all parties agree and change the entire block in question using the hash function and encryption process. Such measures ensure congruent data within the blockchain.

There are three types of blockchain network: public, private, and consortium. Each of these types has its own specific characteristics and operates in its own unique way.

The **Public Blockchain** is a fully decentralized network accessible by all connected devices. Any individual or entity can use a public blockchain to create and validate transactions without needing to request permission from a controlling authority to access the network. Public networks like Bitcoin and Ethereum mainly operate on a consensus basis. They build a blockchain and update the public transaction ledger by generating a block of transactions

Diagram 2: Adjacent Block Components in the Blockchain



Source: Chen, S., Wang., H. & Zhang. L.-J. (2018).

Diagram 3: Differences Between Public, Private, & Consortium Blockchains

Private	Consortium	Public	Types of Blockchain
Single Organization	Multiple Organizations	No centralized management	
Permissioned	Permissioned	Permissionless	Participants
Identified	Identified	Anonymous	
Trusted	Trusted	Potentially malicious	
Consensus Algorithm	Consensus Algorithm	Proof of Stake, Proof of Work, etc	Consensus Mechanism
Low Energy Consumption	Low Energy Consumption	High Energy Consumption	
Short (1/10 second)	Short (1/10 second)	Long (Bitcoin ≥ 10 minutes)	Transaction Approval Frequency
Cost cutting, transparent & secure, faster transactions, less data redundancy	Cost cutting, transparent & secure, faster transactions, less data redundancy	Decentralized & no middlemen needed to complete transactions	Main Benefits

Source: Data derived from Guar, A. & Zhiwen, L. (2018)

** Based on operational needs and exigencies, organizations select one of the three types of blockchains evaluated in Table 1.*

and affixing them to blockchains after gaining the approval of all involved parties. The public blockchain uses anonymous identities and tokens to protect data privacy and confidentiality. All together, it takes approximately 10 minutes to complete the consensus process and validate each transaction.

The **Private Blockchain** is a network in which a specific authority grants permission to view and update the transaction ledger. Internally, private blockchains are used to manage databases by utilizing blockchain properties and features to simplify operations, remove redundant data, facilitate accuracy, reduce costs, preserve records, and ensure transparency. Private networks only take about a tenth of a second to validate each transaction.

The **Consortium Blockchain** is a partially open network that grants permission to create and update transactions to a specific set of authorized, directly correlated, or interconnected entities.

This could include, for example, a group of businesses, banks, hospitals, or government agencies that need to integrally verify common transactions. "Ripple," which enables banks and financial institutions to use blockchain for authorized transactions and money transfers while benefiting from its analytic tools and operational features, is one such example of a consortium blockchain

PART 2: BENEFITS & ADVANTAGES OF USING BLOCKCHAIN FOR TRANSACTIONS

Among the advantages summarized below, blockchain systems can be used to increase operational efficiency and boost developmental, innovative, and competitive capacities across all economic sectors.[1]

REMOVAL OF MEDIATORS

Blockchain systems allow parties to complete transactions and exchanges without relying upon third-party mediators like banks to execute transactions and ensure trust and security. This increases transaction confidence and speed while reducing costs. Blockchain's lack of mediators is particularly useful in complex or difficult cases. For example, it could ease provision of monetary aid to people in conflict zones or areas that lack a means of financial recordkeeping.

DECENTRALIZATION

Unlike centralized databases in which data storage and management is the sole responsibility of a specific authority, blockchain systems use a decentralized database and stockpile replicate data in public ledgers accessible by each of the network's interconnected devices. This facilitates and expedites collaboration and activity between parties while reducing the data's susceptibility to being hacked, lost, changed, or destroyed. Indeed, 50 percent of a network's devices would have to be breached simultaneously to manipulate any of the database's information

TRANSPARENCY & TRUST

Compared to current ledger regimes, blockchain systems enhance the level of trust in a transaction ledger because all of a network's connected devices can view every change made to a public transaction ledger. Further, any modifications require the approval of all involved parties. Moreover, blockchain transactions cannot be deleted from the ledger, greatly enhancing transparency and trust compared to current transaction systems.

INFORMATION SECURITY

Once blocks have been created and attached to the chain, blockchain data cannot be changed unless all followers of a newly created block agree to modify it. Each party can also view interconnected blocks' historical progress and modifications, meaning that transaction details can be easily tracked. This reduces the likelihood that a public transaction ledger — which appears on all of the interconnected devices on a network — can be manipulated or defrauded.

REDUCES TRANSACTION COST WHILE INCREASING SPEED

With no third-party mediators, blockchain systems help reduce costs because the public transaction ledger is distributed across all of the network's interconnected devices. As such, any party can access and adjust transactions that are all subject to immediate and direct review. Because blockchains eliminate the need to rely on banks as a third party to verify the payment process, blockchain reduces the time needed to complete a transaction while cutting costs.

Blockchain is being used to create logistical platforms linking ports with factories, companies, importers, and exporters, helping to expedite trade. (*Photo by KARIM SAHIB/AFP via Getty Images*)

PART 3: THE MOST NOTABLE SECTORS ADOPTING BLOCKCHAIN SYSTEMS

Blockchain has evolved from a mere technological framework for the exchange of the digital currency Bitcoin to a system with advanced applications that are beneficial to the operational, commercial, and industrial sectors.

Some of the most notable areas that are already benefiting from blockchain technology include the protection of the "Internet of Things" (IOT); the provision of governmental and institutional services and transactions; delivery/ supply chain management and logistics; financial transactions; healthcare; and the protection of intellectual property, distribution, and publishing rights in — among other areas — research, literature, music, and the arts.

INTERNET OF THINGS (IOT)

Cybersecurity is one of the most crucial challenges facing IOT, particularly in light of growing cyberthreats and the need to defend the "things" themselves while examining the data collected from them. Blockchain technology protects communications processes by safeguarding the identify of the transmitting and receiving devices; examining and validating collected data; and recording updates and transactions involving this data. For example, household electricity meters or electric vehicle charging stations use smart contracts in the blockchain to automatically and immediately examine and validate device data while recording electricity and payment transactions.[2]

GOVERNMENT & INSTITUTIONAL SERVICES

In general, the benefits of blockchain — particularly transaction speed, transparency, and trust — can be used to provide and improve government services and institutions. Applications include issuing official documents like identity cards, birth and marriage certificates, university diplomas, and driver's licenses; recording ownership of land, properties, vehicles, precious jewelry, and anything else of material value; examining data; distributing government assistance to beneficiaries; and voting digitally in national elections, among other uses.[3]

DELIVERY, SUPPLY CHAINS & LOGISTICS

Blockchain systems will play a central role in expanding commercial ties and overcoming obstacles to global trade over the next few years. Currently, blockchain is being employed to create

logistical platforms linking ports with factories, companies, importers, and exporters. Such development helps facilitate interactions between these entitles and expedite trade. Using digital copies of shipping documents and policies, these platforms — particularly maritime ports — can process and track various data relating to millions of containers and shipments. Better handling data like prices, bills, and production dates eliminates operational complexities, reduces shipping expenses, and cuts down on document processing costs. All of this increases the level of security and transparency while guarding against fraudulent goods and price manipulation.[4]

FINANCIAL TRANSACTIONS

The sector currently undergoing the most significant structural changes as a result of the rise of blockchain is financial services. Individuals and institutions that provide rapid payment and digital currency or asset exchange services directly and securely benefit from the decentralized nature of the blockchain. This is because they do not need a financial market or banking system mediator to complete these transactions. The blockchain is also being used to make immediate wire transfers, particularly abroad, and rapidly settle accounts with corresponding banks and financial institutions, reducing the steps and time needed to make transfers while cutting costs.[5]

HEALTHCARE

In accordance with international patient privacy standards and measures, the healthcare sector is using blockchain to create platforms to record medical data and provide necessary information for medical analyses, studies, and research. This facilitates the work of hospitals, financial institutions, health insurers, medical supply companies, pharmaceutical firms, and other personnel that review medical records.[6]

PROTECTING INTELLECTUAL PROPERTY RIGHTS

Blockchain technology enables the creation of platforms for registering and documenting works like research papers, books, films, music, and graphic and visual arts to protect intellectual and financial property rights. For example, blockchain is used to ensure adherence to the rules and regulations for citing published academic resources. It can also be used to regulate production and guarantee publishing and distribution rights in any field.[7]

PART 4: BLOCKCHAIN ADOPTION IN THE GULF STATES: CURRENT PROJECTS AND FUTURE TRENDS

Interest in the adoption of blockchain technology in the Gulf states began in 2016. It started in the United Arab Emirates (UAE), Bahrain, and Saudi Arabia, especially in the financial and government services sectors. Bahrain focused on studying the legal aspects of blockchain and preparing the requisite regulatory and legal frameworks before starting to use the technology for financial services and digital documents. Meanwhile, the UAE and Saudi Arabia concentrated on researching and examining current and future applications of blockchain systems for government, financial, and commercial services.

Given the nature of blockchain technology, it has a number of impacts and implications for administrative procedures, operations, and systems in various sectors in the Gulf states. The region has recently seen a range of developments in areas like finance, government strategy, project planning, and lawmaking that suggest that blockchain will play an influential role in the development and modernization of the Gulf's government, commercial, and financial sectors in the future.

In accordance with international patient privacy standards and measures, the healthcare sector is using blockchain to create platforms to record medical data and provide necessary information for medical analyses, studies, and research. (*Photo by FAYEZ NURELDINE/AFP via Getty Images*)

Most of the current blockchain-based development projects announced by the Gulf states are in the preliminary concept or establishment stage. As is the case in many countries, only a few such projects in the Gulf have entered the experimentation and testing phase due to the newness of the technology and the fundamental changes it promises to bring. Nonetheless, blockchain is expected to spread over the next few years, especially in the UAE, Saudi Arabia, and Bahrain. This dovetails with the findings of UN reports that infrastructure in the Gulf states is prepared for information technology and e-government development.

The Gulf states' positive rankings on the eGovernment Readiness Index (EGDI) reflect the major ongoing efforts that regional governments have made to improve information and communications technology (ICT) infrastructure across all ministries and agencies in recent years. Bahrain and the UAE led the way in the region among a global group of the most advanced and developed e-governments in the 2018 EGDI rankings (see below).

Global Ranking	Gulf Country
21st	UAE
26th	Bahrain
41st	Kuwait
51st	Qatar
52nd	KSA
63rd	Oman

Additionally, the region's governmental and commercial infrastructure is dependent on cloud computing and

the advanced services provided by the Bahrain-based regional headquarters of Amazon Web Services (AWS) and the existence of international laws such as the Law Providing Cloud Computing Services to Foreign Parties in Bahrain — codified by Decree Law No. (56) for the Year 2018 — to support AWS's activities in the ICT sector.

The Gulf states have successfully developed an advanced technological infrastructure that is conducive to processing new digital data and has enabled them to keep pace with and take advantage of modern technological developments, increase efficiency and productivity, and improve government services. In 2018, the UAE government launched the Emirates Blockchain Strategy 2021, which seeks to transfer 50 percent of government transactions to the blockchain by 2021. In 2016, Dubai's government established the Global Blockchain Council, which aims to research current and future blockchain applications and transaction systems. This body has already helped establish several new UAE-based firms specializing in blockchain platform design to develop smart contracts, exchange digital assets, and transfer digital documents.

Saudi Arabia has also signed a partnership agreement with IBM and Elm to discuss strategies for providing government and commercial services via the blockchain.[8] Separately, Bahrain became the first country in the world to pass a Law for the Issuance of Letters and Electronic Transactions — codified by Decree Law No. (54) for the Year 2018 — to establish the appropriate legal framework and support for using blockchain and other types of modern

technologies to conduct transactions in Bahrain's commercial and government sectors. Since 2018, Bahrain's Economic Development Board has also been implementing a national blockchain adoption strategy for government services and the private sector.

Meanwhile, some agencies like the Saudi and Bahraini customs bureaus have actively started testing the use of operational blockchain platforms by piloting blockchain-based supply chain management systems at maritime ports. One such program is TradeLens, which was jointly developed by IBM and Maersk and links maritime ports to factories, importers, exporters, and commercial parties.[9] Bahrain's General Directorate of Traffic also unveiled a blockchain-based vehicle registration program.[10]

In the education sector, some Gulf state universities and educational institutions are adopting blockchain to develop mechanisms for issuing, certifying, and verifying academic degrees. The University of Bahrain decided to issue and encrypt digital diplomas using the blockchain and machine learning technologies in 2019,[11] and the British University in Dubai started to issue degrees via the blockchain in 2018. This system helps graduates, educational institutions, and employers more quickly certify and verify degrees by scanning codes on digital diplomas. The information is only accessible via a special link (digital certificate) to the university's website that displays, certifies, and validates all requested information contained in the blockchain network.[12]

Universities and research institutes like King Abdulaziz City for Science and Technology[13] and the Bahrain Institute of Banking and Finance have also developed and introduced blockchain-based pilot projects and training programs.

Another sign that blockchain adoption and usage in the region will continue to expand is the fact that central banks and monetary authorities across the Gulf understand its importance to the financial sector. This is embodied by the use of blockchain platforms by regional banks, businesses, and financial institutions to more quickly and inexpensively transfer crypto funds and assets to local and regional counterparts.

For example, the Central Bank of Bahrain (CBB) spent a significant amount of time studying the strengths of blockchain cryptoassets before establishing a relevant regulatory framework. The policy ultimately included licensing, oversight, cybersecurity, and governance standards. In early 2019, 28 local and regional firms seeking to offer cryptoasset financial services had joined the CBB-provided "regulatory sandbox framework." This ensures that the advanced blockchain programs they piloted met organizational needs before their commercial launch. The CBB also collaborated with Bahrain's eGovernment Authority and The Benefit

Company (BENEFIT) on a "Know Your Customer" (KYC) initiative that used blockchain to verify and validate data required to provide consumer banking services.[14]

The Saudi Arabian Monetary Authority (SAMA) has joined the RippleNet allied banking blockchain network to help domestic banks settle payments and transactions with regional banks to make secure monetary transfers faster and cheaper.[15] In keeping with this trend, Al Rajhi Bank made Saudi Arabia's first-ever blockchain wire transfer from its Riyadh headquarters to one of its branches in Jordan.[16] Meanwhile, the UAE and Saudi central banks have both discussed launching a blockchain-based digital currency for cross-border transactions.[17]

In the UAE, the Abu Dhabi Securities Exchange (ADX) signed a memorandum of understanding with seven central securities depository (CSD) companies charting a path for adopting blockchain and utilizing distributed ledger technology. This could figure in the post-trade landscape for various institutional functions like voting and proxy voting to bolster current standards such as the ISO 2022 character encoding system).[18] The ADX's agreement will help determine which regulations and standards must be enacted to facilitate the successful adoption of blockchain in the post-trade environment. It will also expedite and further secure financial securities transactions in the UAE and the Gulf.

Table 2: Current Phase of the Three Sectors of Blockchain Projects in the Gulf States

Complete	Piloting/Implementation Phase	Under Review	
■ Bahrain passed legislation & laws on the use of blockchain platforms & exchange of digital assets	■ Emirates Blockchain Strategy 2021 ■ National Blockchain Adoption Strategy (Bahrain Economic Development Board) ■ Using blockchain platforms for customs bureau operations at maritime ports in coordination with private sector partners	■ Providing government services (UAE & KSA)	**Government**
■ Central banks & monetary authorities authorized use of and integrated blockchain platforms into their banking alliances ■ Central Bank of Bahrain issued draft rules for cryptoassets, launched regulatory sandbox to test products and systems ■ Using blockchain platforms to transfer money and make banking & securities transactions ■ Licensing companies to exchange virtual currencies (UAE)	■ Validating customer data for banking services (Know Your Customer (KYC))	■ Joint Saudi-Emirati digital currency for inter-bank transfers ■ Revising laws & regulations governing virtual transactions ■ Commercial use of blockchain platforms for digital payments	**Finance & Banking**
■ Training programs for blockchain systems	■ Issuing university degrees (Bahrain & UAE)		**Education**

Source: Research conducted by the author for this section (Part 4) of the report

In 2018, Abu Dhabi's Al Hilal Bank used blockchain to sell some of its $500 million issue of sharia-compliant bonds, or *sukuk*. Considered the world's first-ever blockchain sukuk transfer, this move paved the way for Gulf-based Islamic banking institutions to integrate the blockchain to enhance and facilitate financial transactions.[19] Gulf state communications firms have also revealed that they have incorporated studies on the use of blockchain to make digital payments into their future operational and service development plans.[20]

Table 2 provides an overview of the current status of blockchain projects in the Gulf states announced between 2016 and 2019, broken down by sector.

Analysis of the relatively limited information available about blockchain adoption in the Gulf states clearly shows that some regional government agencies, central banks, and financial institutions are seeking to use it to enhance their operations and service systems — efforts that can be summarized as follows:

1. Studying and planning for how to convert to blockchain to manage and conduct current operations or make use of its capabilities for new projects in the future is already underway.
2. Some entities are actively testing, piloting, evaluating the usefulness of, and benefitting from blockchain systems.
3. The necessary conditions for adopting blockchain systems — and the resultant need to rewrite

The Saudi Arabian Monetary Authority (SAMA) has joined the RippleNet allied banking blockchain network to help domestic banks settle payments and transactions with regional banks to make secure monetary transfers faster and cheaper. (*Photo by Jack Taylor/Getty Images*)

procedures and rules for action and coordination among stakeholders — are being studied.

Despite these efforts, blockchain projects in the Gulf states are only in their early stages and, like in many other countries, full adoption of the technology is rare given how new it is. Nonetheless, the current state of blockchain adoption in the region indicates that the Gulf states are entering a new phase of digital transformation. In its new form, managerial thinking and workflow are premised upon blockchain standards — most notably the transparency, decentralization, and disintermediation of the transaction process, as well as the high degree of interconnectivity between economic sectors and actors. Such changes have brought the Gulf states' public, financial, and private sector institutions to a new threshold of competitive and developmental capabilities, helping them to innovate and modernize services while improving their level of efficiency and productivity.

The Gulf states' work on current projects has also led local and foreign investors from leading and specialized firms to provide pilot blockchain services and offerings in areas like banking, ports, customs bureaus, and universities. In turn, this has incentivized agencies and organizations to expend greater effort to illustrate the operational benefits and competitive value of embracing the blockchain transformation. It has also encouraged these entities to discuss drafting laws and operational and organizational regulations needed to ensure the secure, meticulous, and appropriate use of blockchain for government, financial, and commercial services.

PART 5: THE PREVALENCE OF BLOCKCHAIN TECHNOLOGY IN OTHER COUNTRIES

This paper has reviewed the more than 200 currently announced government-funded blockchain projects in other countries — most of which have been launched in Europe and West Asia[21] — to understand how well Gulf state governments are keeping pace with blockchain adoption and use at the global level. For the purpose of this analysis, government projects currently underway in various countries have been classified by sector and sorted into four categories based on international prevalence. The study found that more than 50 types of projects are extremely prevalent, 20-49 types of projects are highly prevalent, 10-19 types are moderately prevalent, and fewer than 9 types are marginally prevalent.

The data in Table 3 (on the next page) shows that there are more than 50 research studies of blockchain

technology around the globe. Currently the most prevalent type of project, these initiatives seek to research and determine the relevant components of blockchain technology in given economic fields. The studies also outline the strategies and standards that must be implemented for a successful blockchain transformation.

The second most prevalent type of blockchain project are programs pertaining to the administration and storage of personal records, including financial and medical information; identity programs like the issuance and validation of credentials, licenses, and diplomas; economic development projects; and the expansion of financial services.

The third most internationally prevalent type of blockchain projects include programs pertaining to the storage of land management records; issuance of digital currencies by central banks; benefits administration; compliance; and supply chain management.

Table 3: Government Blockchain Projects in Various Countries by Field & Prevalence

Field	# of Projects	Prevalence
Strategy/research/standards	51	Very High
Personal records (health, financial, etc)	25	High
Identity (credentials/licenses/attestations)	25	High
Economic development	23	High
Financial services	20	High
Land title/registry	19	Moderate
Digital currency	19	Moderate
Benefits/entitlements	13	Moderate
Compliance/reporting	12	Moderate
Trade/supply chain management	10	Moderate
Voting/election	7	Low
New product/services	7	Low
Payments	6	Low
Asset registry	6	Low
Public transport	6	Low
Data marketplace/data monetization	6	Low
General infrastructure/public records	6	Low
Public utilities	5	Low
Regulatory	4	Low
Tax collection/credit	4	Low
Government finance	4	Low
Cybersecurity	3	Low
Legal enforcement/courts	2	Low
Military/defense infrastructure	2	Low
Digital token	1	Low
Internet of Things	1	Low

Source: The Illinois Blockchain Initiative (2018)

The least internationally prevalent type of blockchain projects are being implemented in more than 15 distinct fields including voting and elections; public utilities and transportation; laws and legislation; courts and legal authorities; and taxation and appropriation.

Comparing the above data, we find that the Gulf state governments are keeping pace with global trends for blockchain usage and that the goals of the region's current blockchain projects — which aim to employ blockchain systems to digitize public services and increase transparency and efficiency — are similar to those of governments elsewhere.

The Gulf states' projects also lie within fields that have a high degree of international prevalence, specifically the research sector, which is using blockchain technology to craft relevant national strategies, legislation, and regulations; the financial sector, which is using blockchain to conduct banking and financial services, exchange cryptoassets, and issue digital currencies; and the commercial sector, which is using blockchain to enhance import and supply chain management operations at maritime ports.

CONCLUSION

The preceding discussion shows that the world is increasingly inclined to take advantage of blockchain systems and their positive impacts upon all economic sectors, development, and improvement of the quality of life. Because the Gulf states already possess a highly-developed ICT sector, some Bahraini, Saudi, and Emirati government agencies, financial institutions, and educational establishments understood the need to keep pace with this trend and start planning and preparing for the blockchain transformation. In coordination with specialized international firms, many of these Gulf-based organizations are now piloting projects designed to learn how use blockchain applications to enhance operational systems and mechanisms while establishing new methods for providing services.

Some of these organizations have also examined the regulatory and legal standards that must be implemented to operationalize blockchain systems and create an environment conducive for their use in providing public services and operating economic sectors at the local, regional, and international levels.

However, many Gulf state institutions still lack public plans for operationalizing blockchain technology or still need to research and keep up with international blockchain usage in their specific fields. In order to further incentivize blockchain adoption, Gulf states should:

1. Define on a practical level how blockchain systems work and why their adoption reduces and simplifies operational procedures while boosting developmental, innovative, and competitive capacities.

2. Conduct an ongoing review of news about blockchain system standards, advantages, and requirements to benefit from the applied experience of public institutions, government agencies, and leading companies currently utilizing blockchain technology.

3. Expend greater effort to lay the foundation for the blockchain transformation, particularly among countries that have yet to establish a national committee or strategy for utilizing the technology, by encouraging all public and private sector entities to collaborate on studying the development-specific benefits gained from using the technology and its capabilities and systems. These entities should also discuss additional operational and organizational procedures and legal regulations that need to be enacted to transfer operations and transactions to the blockchain.

4. Encourage the private sector to adopt blockchain and invest in projects designed to expand and operationalize it while also incentivizing top global blockchain firms to enter Gulf markets and provide their pilot services and offerings to public and private sector institutions.

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ABOUT THE AUTHOR

Dr. Fatima AlSubaei is an analyst at the Bahrain Center for Strategic, International and Energy Studies (Derasat).

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