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Research Article

Blockchain Applications Issues and Challenges

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***Abstract*—** Today, blockchain technology is used in various fields and received a lot of attention from industry and academia due to its unique properties. Cryptocurrency is popular and takes place in industry, academic, and banking worldwide for various transactions. Blockchain is a term which is constantly changed the world and our lives. It is a chain of blocks that store information with digital signatures. It is a decentralized, incorruptible, and open ledger that records the transaction between two parties securely, verifiable and immutable. The transaction of records in the blockchain remains unchanged due to its immutable nature and all the records are verified and available to all the nodes of the block. The consensus algorithm to make ensure network safety and security at the time of computation. In this paper, we are trying to review blockchain technology of last one decade on various parameters. This paper is divided into phases. First phase is exploring the applications of blockchain in some areas like energy, finance, healthcare, government, etc. second phase focused on various issues and challenges of blockchain of recent advances have been reviewed. In third phase, challenges of blockchain and the future scope of blockchain technology. This review paper will be benefited as an unbiased direction for the researchers.

***Keywords*—** *Blockchain, Decentralized, Open Ledger, Verifiable, Immutable.*

I. INTRODUCTION

Today, people depend on the digital world, various systems communicate with each other for information exchange. As a user, they expect every interaction between the devices to be safe and reliable [1]. Blockchain is one of the important technologies that highlight the new models and alterations in the field of the Internet of Things (IoT) and Artificial Intelligence (AI). Blockchain is a secure and flexible mechanism for connecting peer-to-peer and transfer the data or any value with an immutable property. It is one of the evolving technologies promising a well-organized, reliable, cost-effective, and secure system. It is an incorruptible digital ledger of economic transactions that can be programmed to record financial transactions [2]. Blockchain is the digital, decentralized, distributed ledger that stores the information about financial transactions without an external authority like a bank overseeing the transactions [3].

Blockchain innovation empowers the “production of a decentralized domain” [3]. It allows industries to store records of any type of blockchain. It is a collection of records which is known as blocks and are connected to every other block using cryptography[4]. The transactions of the nodes are stored in the network. When any new transactions will be executed, it has to be verified. The verification is achieved by the consensus. There are different methods to achieve the consensus. Blockchain can be updated without consensus. Each block is connected with
the previous block via reference which is known as the value of the previous block called a *parent block.* The initial block of the blockchain is known as *genesis* which has no parent and the blocks are added known as *child block.*

II. TYPES OF BLOCKCHAIN

Every blockchain is a growing collection of records. It is a technology that gains our trust and makes our work easier. There are three types of blockchain as shown in figure 1 [5]**.**

Public Blockchain:

It is the public blockchain for the open-source that allows anyone to be engaged in users, miners, developers, or community members [2][6]. The details of the transaction are available to all the members connected to the network. It is fully decentralized and highly security resistant as shown in figure 1[7].

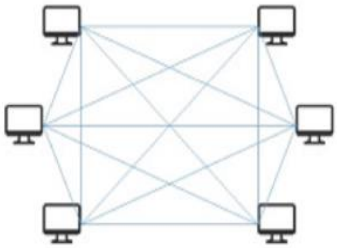

Figure 1: Public Blockchain

Private Blockchain

It is essential to get authorized to join the network. They are centralized and the transactions are private[8]. It is also known as permission blockchain which is shown in figure 2.

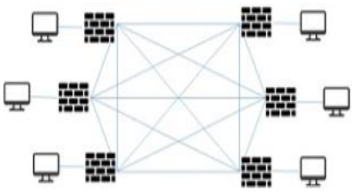

Figure 2: Private Blockchain

Hybrid Blockchain

It is a public and private both characteristics. The security sake and transparency help the business people to have more trust [9]. It allows a multi-chain network in blockchain technology as shown in figure 3.

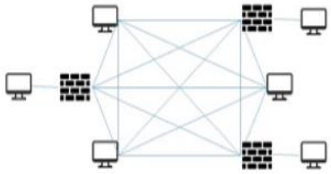

Figure 3: Hybrid Blockchain

III. BLOCKCHAIN BENEFITS

It is a peer-to-peer network in which various stakeholders know each other and may locate in various geographical locations[10]. It is very useful in various fields which are as follows:

- Blockchain increased the security of the network as each transaction is first agreed upon participant and the transaction gets approved. It is encrypted and linked to the previous transaction in the blockchain. The information is stored on the networks of computers instead of on a single server computer. Therefore, it becomes very difficult for the hacker to compromise the transaction done on the blockchain [11].
- Blockchain doesn't need a central authority, it is a complete decentralized system. Everyone who is part of the network is completely responsible for each transaction. So, there is no single authority in the blockchain network [12].
- As the complete blockchain is shared with each node, all the nodes verify each transaction. This makes duplication difficult in the blockchain network.
- Blockchain reduces the cost of a transaction, as there is no central authority managing all the transactions, each participant is equally responsible for the transaction.
- Blockchain is immutable i.e. it cannot be tempered as blocks are attached using hash functions and an encryption algorithm.

IV. WORKING PROCESS OF BLOCKCHAIN

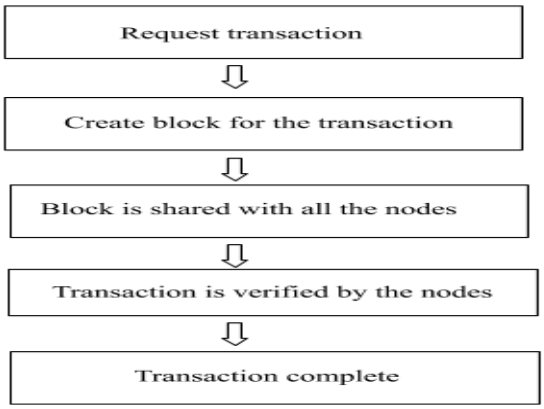

Figure 4: Working Process of Blockchain

The working process of the blockchain is to send a transaction request then a block is formed for the transaction. The transaction is shared with the nodes then verify the transaction. The transaction is verified from the block and some rewards are added to the blockchain. The process is carried out by binding the block to the other blocks in the blockchain as shown in figure 4.

V. BLOCKCHAIN APPLICATIONS

It is used in various applications. Bitcoin is one of the popular applications in blockchain technology. This technology is used in various applications to find solutions of various domains like healthcare, e-voting, e-residence, cyber-security, supply chain, etc. [13]. Some of the experts said that it has the same potential as the internet introduces the first time. When the internet introduces, we have no idea that how it is involved in our routine lives. Presently, more than 50 companies use case plans are implemented and used in various applications all over the world of blockchain technology[14]. It is used as a ledger system that controls all the transactions in a decentralized manner over the distributed network. There is a lot of future scope in this field for development. Here we discuss some of the areas which are as follows:

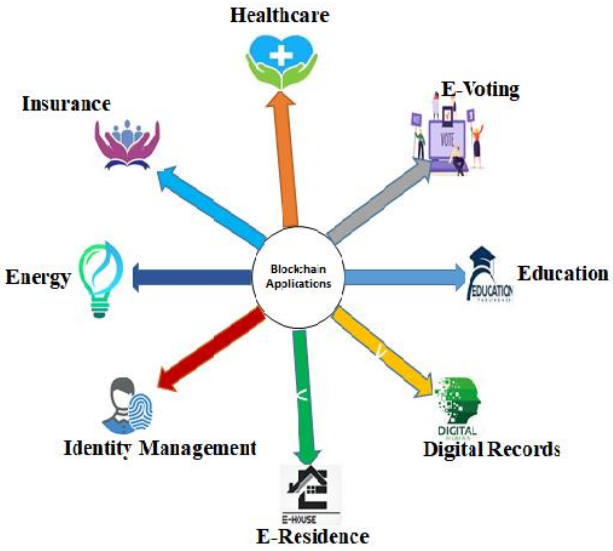

Figure 5: Blockchain Applications

Healthcare: Distributed technology has the potential to transform the data used in the healthcare industry. The healthcare sector is continuously improved and demands blockchain development. A various survey done by Deloitte, expressed that traditional healthcare is required to update for the use of blockchain [15][16]. The immutable feature of blockchain can secure healthcare records. Blockchain can also be used in the real-time patient monitoring system and medical interventions [16].

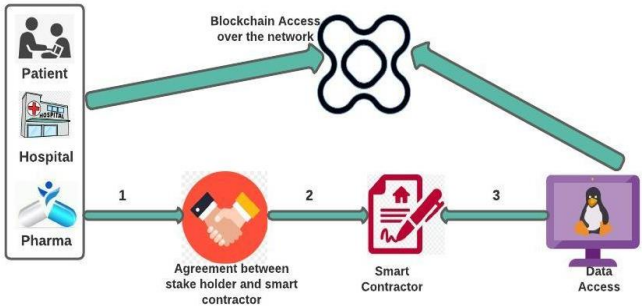

Figure 6: Blockchain in Healthcare

Identity Management: Every citizen has a personal identity that can be required at the time of verification like passport, driving license, Adhar card, PAN card, etc. However, there is not any technology for securing these identities. Blockchain is used to provide a secured environment for an individual's identity from the attackers and try to optimize the frauds. Paul Dunphy et al proposed identity management, by using distributed ledger technology to enhance the decentralized, transparency and controls on the network [17].
E-Voting is one of the processes that makes privacy and honesty of traditional voting system. The objective is to replace the pen and paper ballet with a new technology that has the potential to limit fraud during the voting process traceable and validate in [8]. During availing of this facility, the transparency and flexibility provided is a big challenge. By using an Ethereum private blockchain, thousands of transactions can be executed in a fraction of seconds by using this technology [7].
Estonia became the first country in 2014 to start eResidence. The eID is provided for commercial purposes in the public and private sectors [6]. The application of blockchain makes a drastic change in the identity information to control and authenticated the eResidence people [6].

Government: It is one of the important domains where security and privacy are required. From literature review and study, it is found that blockchain can improve by interfacing the Government tools, creating a digital identity, and improving the measurement regulation [18].

Energy:
It is one of the important applications used in micro-grids. It is a set of sources for load integration, distribution and managed to augment the energy production and consumption [19]. This energy can be allocated in different ways like power generators, renewable energy, energy storage, or energy providers. It can be used to provide to maintain records and validate the power data of buying and selling transactions in the energy industry [20]. Blockchain can also be used in energy trading in the Industrial Internet of Things (IIoT) [21].

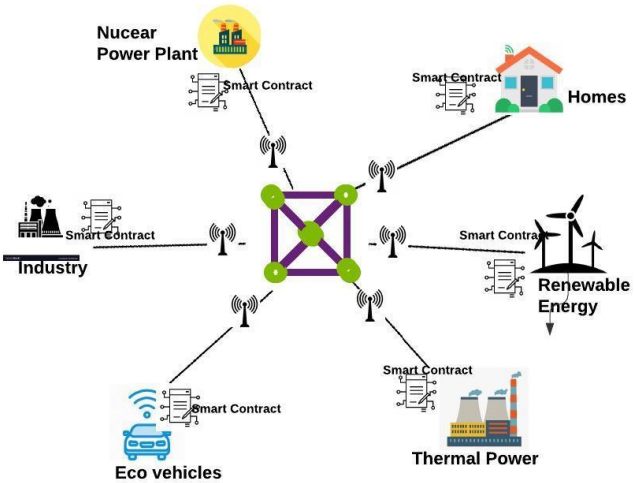

Figure 7: Blockchain in Energy

Finance: Finance is one of the domains with a lot of exposure using blockchain technology. From the studies and review paper, it is found that using blockchain applications, can improve in finance for better transaction processing, sustainability banking, and finance, to improve financial security and maintain the privacy of financial contracts [10].

Table 1: Blockchain application solutions

Blockchain Applications	Solutions and suggestions	Ref.
Healthcare	Access of Medical Records	[13] [22] [23]
	Sharing of Medical Records on Network	
eVoting	eVoting information available	[8] [20]
	Security and privacy is maintained	
eResidence	eID of residence is provided	[6]
	To control and authenticated the eResidence	
Identity Management	To secure the identities	[24] [25]
	Identity should be available on distributed ledger.	
Finance	To improve the transaction processing	[10] [13] [18]
	Improving banking and finance transaction	
	Improve transaction security	
	Compilation of financial contracts	
Government	e-Government Information	[6] [13]
	To create digital identity	
	To improve the regulations	
	To improve the privacy of information	
Energy	To control the energy markets	[13] [26] [27]
	To improve the energy trading	
	To enhance the security of the grid	
	To encourage the green energy	

VI. ISSUES AND CHALLENGES

Although blockchain holds tremendous potential to improve and add value to the healthcare system and several companies have already started testing for specific use cases. There are several challenges to be tackled before its mainstream usage. There are various facets to the challenges of the mainstream adoption of blockchain technology. These facets are technical, legal, business, and trust issues [4].

Interoperability & Integration with the Legacy Systems

The healthcare industry is a vast field with a large number of devices and technologies. It is difficult to inculcate blockchain technology in the healthcare industry at once, as there exists a problem of interoperability due to the use of a large number of devices with different technology in this field[17].

Adoption and incentives for participation

The use of blockchain in the healthcare industry requires participation and coordination among a large number of stakeholders. These stakeholders can be pharmaceutical companies, hospitals, product manufacturing units, and device manufacturers. To inculcate blockchain these stakeholders need to change their current business model. To change the business model the stakeholder can expect some incentives. So new business models need to be explored to meet this expectation.

Uncertain cost of operation

As blockchain has so many eminent features such as decentralization, immutability, transparency, and security. The cost of operating blockchain cannot be approximated at this point[5].

Regulation

Blockchain technology is at its infancy stage, one of the important challenges faced the lack of regulation or how this technology will comply with the existing regulations and guidelines. There should be proper regulation for the use of blockchain technology in the healthcare industry as in this industry patient's health and life both are at stake. To achieve this, many pilot deployments and rigorous tests and validation of the underlying technological pieces must be considered by the solution providers. The requirements to adhere to regulations could also be an impetus for further technological advancements in blockchain technology [28].

Governance

The basic premise of the distributed nature of blockchain helps to bring multiple parties into a trusted transaction scheme, without the need for any centralized authorities. However, if we consider how healthcare organizations operate, there can be several different operational models. In certain operational models of blockchain-based solutions, it might be imperative to have a certain stakeholder assuming the role of a regulator to govern the overall operation of the blockchain [16]. This governing model might be needed to meet the regulatory requirements. It is not yet clear how such a governance structure can be managed properly in a system with multiple disparate parties. This aspect of governance will also have a tie-in with the intended incentive schemes. However, as the adoption of blockchain-based solutions will evolve in the healthcare space, we would see various solutions also to the requirements of governance [29].

Scaling

Not only in healthcare all the industry, but underlying blockchain network has to be scalable for successful application of any blockchain-based solutions. It is likely that, at least in the early phase, several solutions in healthcare will use semi-permission blockchains which are scalable and have high transaction throughput at the cost of decentralization[43]. However, there will still be a need for public blockchains for communication among permission blockchain networks. Besides, a blockchain-enabled global HIE can only be possible with highly scalable public blockchains. In the current form, public blockchain networks like Bitcoin and Ethereum are not fast and cheap enough to host any decentralized applications on a large scale[9]. However, there have been several ongoing scaling efforts such as lightning networks, state channels, plasma chains, sharing, zk-snarks, etc. and some of them are already being adopted in practice. In the future, public blockchains will be fast and cheap enough for their mass adoption.

Table 2: Blockchain Challenges

D	L		Applications	Ref.

		Nature	Governmen	Finance	Healthcare	Manufacturi	Identity	
Challenges	Environmental	Regulations	√	√	√	√	√	[15] [32]
		Liabilities				√	√	[33] [25]
		Sustainability	√	√	√			[16]
		Convenience	√	√		√	√	[34]
	Adopti	Interoperability	√	√		√		[25]
		Uniformity	√	√	√	√	√	[20]
		Consistency	√	√		√	√	[35]
	Technological	Privacy	√		√	√	√	[14] [36] [37]
		Security	√	√	√	√	√	[16] [34]
		Efficiency	√	√	√			[28] [38]
		Integrity		√	√		√	[39] [40]
	Execution	Maintenance	√	√		√		[15]
		Flow management				√		[31]
		Availability		√		√		[41]
		Performance	√	√	√	√	√	[15]
	Organizational	Risk		√			√	[4] [17]
		Structural	√					[5] [42]
		Agreement		√		√		[5]
		Transformation	√	√	√	√		[4] [5] [10]

Privacy: It is generally used to maintain privacy and security for confidential data as users can operate transactions on the network. As many researchers suggested that these transactions are not safe in blockchain technology in the case of the public key used on the network which is visible to all the nodes [30]. Biryyokv et al. also proposed a method and defined that nodes can be uniquely identified through their connection[31].

VII. Future Scope of Blockchain Technology

Researchers believe that there is a lot of potential in both academia and industry by using blockchain technology. It also allows creating a digital certificate for the new inventions, which can prove the

integrity, existence, and ownership of all the identities records. By using cryptography techniques, all the confidential data like copyright, patents, or trade secrets could maintain privacy and security.
From the research, it is also found that big data analytics could also be combined with blockchain. It is used to stored data in a secured and distributed manner to manage data. By using the immutable feature of blockchain, ensure the authenticity of the data.
A smart contract can also be used in blockchain technology. Szabo et al. discussed in [17] a smart contract of digital transaction that compiled the rules and policy of contracts.

VIII. CONCLUSION

This paper focused on the applications of blockchain technology. A blockchain is a tool that can solve all the problems of various applications like government, energy, finance, environment etc. Since the blockchain is immutable and traceable; the transactions will remain maintained in the network and available to all the nodes. This technology is accomplished and amalgamated with the other technologies and reinforce the other sectors. We first provide an overview of the types of blockchain including blockchain applications and benefits. Further, we also listed the challenges and issues that hamper the field of blockchain development and highlight some additional future scope in this area for researchers. Adequate research is still required to explore the blockchain and its desirable applications.

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