Revolutionizing Industries and Transforming Transactions: The Promising Future of Blockchain

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Abstract: *Blockchain technology has emerged as a disruptive force with the potential to revolutionize industries and transform the way transactions are conducted. This paper explores the promising future of blockchain, highlighting its fundamental principles, features, and potential applications across diverse sectors. By examining the transformative impact of blockchain on industries such as finance, supply chain management, healthcare, and government, this study elucidates the advantages, challenges, and future implications of widespread blockchain adoption. Through a comprehensive analysis of current trends, case studies, and emerging use cases, this paper outlines the immense potential of blockchain technology to reshape our digital economy and drive innovation.*

1. INTRODUCTION

1.1 Background and Significance

In recent years, blockchain technology has gained significant attention and recognition due to its successful implementation in cryptocurrencies like Bitcoin and Ethereum. Originally introduced as a distributed ledger technology to enable secure and transparent transactions, blockchain has evolved beyond digital currencies, finding applications in diverse industries. Its underlying principles, including decentralization, immutability, consensus mechanisms, and smart contracts, have opened up new possibilities for industries seeking enhanced security, transparency, and efficiency.

The significance of blockchain technology lies in its potential to disrupt traditional industry practices, streamline transactions, and address long-standing challenges. By leveraging blockchain, industries can achieve secure and verifiable transactions, eliminate intermediaries, reduce costs, enhance supply chain transparency, improve data management, and empower peer-to-peer interactions. Furthermore, blockchain technology offers an opportunity to bridge trust gaps, especially in industries where trust is critical, such as finance, healthcare, and supply chain management. Zibin Zheng and Shaoan Xie, Hong-Ning Dai, Xiangping Chen, Huaimin Wang (2018).

1.2 Research Objectives

Examine the fundamental principles, features, and components of blockchain technology.

Investigate the current and potential applications of blockchain across diverse industries, such as finance, supply chain management, healthcare, and government.

Analyze the advantages, challenges, and implications of widespread blockchain adoption in different sectors.

Identify the specific benefits that blockchain technology can bring to industries, including enhanced security, transparency, efficiency, and decentralization.

Evaluate the challenges and considerations that need to be addressed for successful blockchain integration, such as scalability, regulatory frameworks, privacy, and governance.

Showcase real-world case studies and implementations of blockchain technology to highlight its transformative impact on industries and transactions.

Discuss emerging trends, research directions, and future developments in the field of blockchain technology.

Provide recommendations and strategies for organizations and policymakers considering the adoption and integration of blockchain technology.

By achieving these research objectives, the paper aims to contribute to the understanding of blockchain's potential to revolutionize industries and transform transactions, enabling stakeholders to make informed decisions regarding its implementation and adoption.

1.3 Research Questions

How does blockchain technology revolutionize industries by transforming traditional transactional processes?

What are the fundamental principles, features, and components of blockchain technology that contribute to its potential for revolutionizing industries and transactions?

What are the current and potential applications of blockchain technology in diverse industries, such as finance, supply chain management, healthcare, and government services?

What are the specific benefits and advantages that blockchain technology offers in terms of security, transparency, efficiency, and decentralization?

1.4 Research Method

To identify how blockchain technology is revolutionizing and transforming Industries, literature review was conducted and interviews were conducted. Structured literature review was performed based on the systematic literature review approach by Kitchenham (Kitchenham et al., 2010). Based on this approach, 29 articles, papers, blogs and transcripts, with total pages of over 700, were analyzed. The initial search was initiated via researchgate.com based on the keywords “blockchain” AND “transformation” in the period of June 2023–August 2023. In addition to the literature, we conducted interviews with four experts to gain a deep insight into the typical changes and transformation of industries payment process by blockchain technologies. The interviewees were selected based on their practical experiences in different industries and their understanding of blockchain projects. The number of people meeting this main criterion is limited due to the limited focus on practical aspect of blockchain so far. Interviews were conducted with an industry expert in decentralized Application development from Swarm City, an industry expert in decentralized consensus mechanisms and two researchers (an academic scholar as well as a researcher from a not-for-profit organization) who are researching and teaching various blockchain topics, including blockchain and smart contract governance. Lastly, the development of the number of DAOs in time are shown.

2. UNDERSTANDING BLOCKCHAIN TECHNOLOGY

2.1 Definition and Key Concepts

Blockchain is a hotly emerging digital technology and is considered as the fourth generation of the subversive core technological revolution after steam engines, electricity, and the Internet. Blockchain is a combination of a series of concepts. It is essentially a distributed database, which is decentralized, immutable, traceable, transparent, and reliable. Along with the continuous development of blockchain, its application potential has received increasing attention from many countries. In January 2016, the British government released Distributed Ledger Technology:

Beyond Blockchain, which is the white paper of blockchain special research report. Nasdaq took the lead in launching the equity trading platform "Nasdaq Linq" based on blockchain in December 2015. Japan established the Blockchain Alliance in April 2016. In China, a series of policy documents have been issued to promote the application of blockchain. Among them, in the relevant policies to promote the application of blockchain in the construction industry, it is proposed to increase the integration and innovative application of new technologies including blockchain in the whole construction process. The construction industry is a highly decentralized industry, and the lack of a systematic and effective trust system, information sharing, and automation of the process is a problem in traditional construction project management. Emerging digital technologies can help the construction industry integrate fragmented knowledge and information to improve organizational collaboration and communication [4]. In recent years, the construction industry has actively absorbed and applied emerging technologies to solve problems existing in its own development, thereby improving the level of informatization and digitization of the industry. However, with the trend of large-scale and complex engineering projects in the industry and the interaction of various information technologies, data query access is complex, data information is easily tampered with, and storage is too centralized; these and other problems are becoming increasingly obvious. The features of blockchain are a potential tool to solve the problems in the development of the construction industry. Many researchers have recognized the potential role of blockchain in driving the development of the construction industry [6,7], but its practical application is very low. At present, the research on blockchain in the construction industry is mainly focused on exploring application scenarios and mining the application value of blockchain, and rarely research on the adoption mechanism of blockchain in the construction industry. (Xuetong Wang, Lingyi Liu, Jingkuang Liu * and Xiaojun Huang 2022*)*. Alam et al,also stated that in a blockchain network ''Once data is entered, cannot be changed or erased".

2.2 Distributed Ledger Technology

Distributed ledger technology (DLT) refers to the protocols and supporting infrastructure that allow computers in different locations to propose and validate transactions and update records in a synchronized way across a network. The idea of a distributed ledger - a common record of activity that is shared across computers in different locations - is not new. Such ledgers are used by organizations (eg supermarket chains) that have branches or offices across a given country or across countries. However, in a traditional distributed database, a system administrator typically performs the key functions that are necessary to maintain consistency across the *multiple copies* of the ledger. The simplest way to do this is for the system administrator to maintain a master copy of the ledger which is periodically updated and shared with all network participants.

By contrast, the new systems based on DLT, most notably Bitcoin and Ethereum, are designed to function without a trusted authority. Bitcoin maintains a distributed database in a decentralized way by using a consensus-based validation procedure and cryptographic signatures. In such systems, transactions are conducted in a peer-to-peer fashion and broadcast to the entire set of participants who work to validate them in batches known as "blocks". Since the ledger of activity is organized into separate but connected blocks, this type of DLT is often referred to as "blockchain technology".

The blockchain version of DLT has successfully powered Bitcoin for several years However, the system is not without drawbacks: it is costly to operate (preventing double-spending without the use of a trusted authority requires transaction validators (miners) to employ large amounts of computing power to complete "proof-of-work" computations); there is only probabilistic finality of settlement; and all transactions are public. These features are not suitable for many financial market applications. Current wholesale DLT payment applications have therefore abandoned the standard blockchain technology in favour of protocols that modify the consensus process in order to allow enhanced confidentiality and scalability. Examples of protocols currently being tested by central banks include Corda and Hyperledger Fabric. Corda replaces blockchain with a "notary" architecture. The notary design utilises a trusted authority and allows consensus to be reached on an individual transaction basis, rather than in blocks, with limited information-sharing. (Extract from page 58 of BIS Quarterly Review, September 2017).

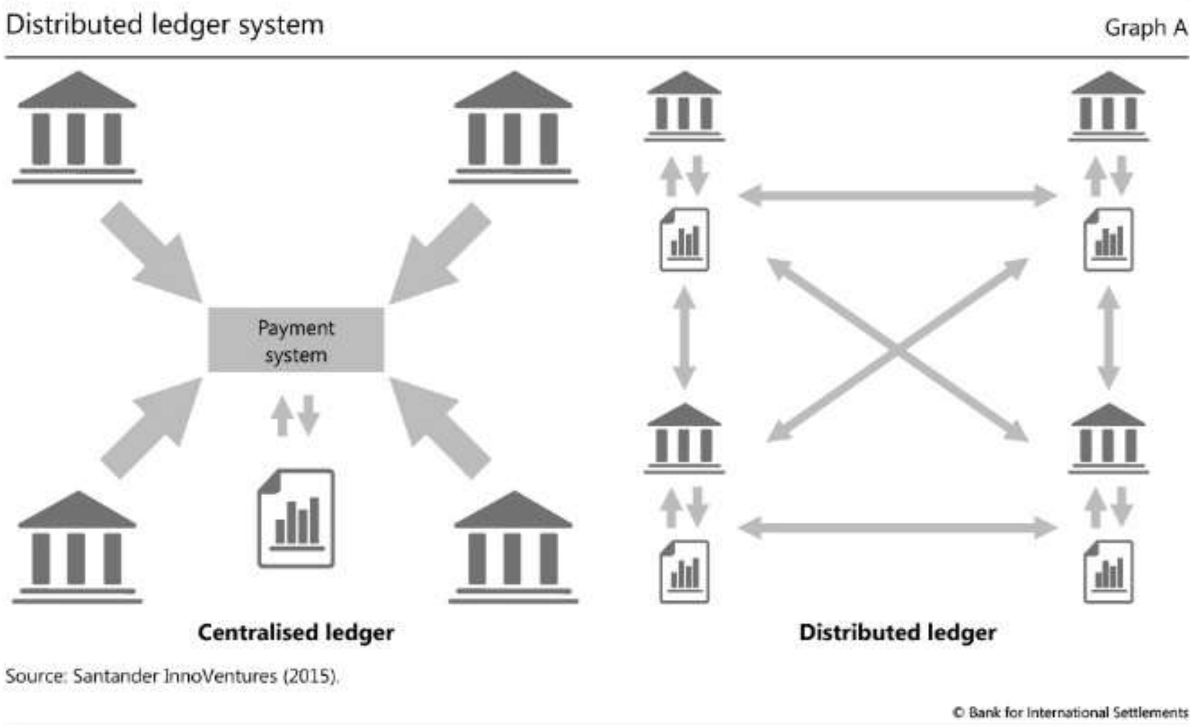

Figure 1: Illustration Of DLT.

2.3 Consensus Mechanisms

The concept of consensus starts with distributed systems. The critical problem addressed by distributed consensus mechanisms is implementing certainty and consensus to return reliable consensus results across the entire distributed network. Before the introduction of blockchain, the consensus mechanisms to solve the problem of consistency and consensus of the distributed system could be considered classic distributed consensus mechanisms. The traditional distributed consensus mechanisms and related technologies have laid a solid theoretical foundation for blockchain consensus mechanisms. The main theoretical foundations of blockchain consensus mechanisms come from different fields, such as distributed systems from computer science, cryptography from mathematics, and game theory from economics.
The incentive mechanism of blockchain technology conforms to incentive compatibility theory. This theory was proposed by the economist Leonid Hurwicz in 1973. Its main idea is to admit the selfishness of human nature and then achieve agreement between individual and collective interests with the help of a particular mechanism. The incentive mechanism provides motivation

and guarantees for reaching a consensus. Subsequently, the economist Hayek published the book Denationalization of Money in 1976, considered the ideological source of digital currency
The theoretical bases of blockchain consensus mechanisms are shown below. Sisi Zhou, Kuanching Li, Lijung Xiao, Jiahong Cai, Prof. Wei Liang, Prof. Arcangelo Castiglione 2023.

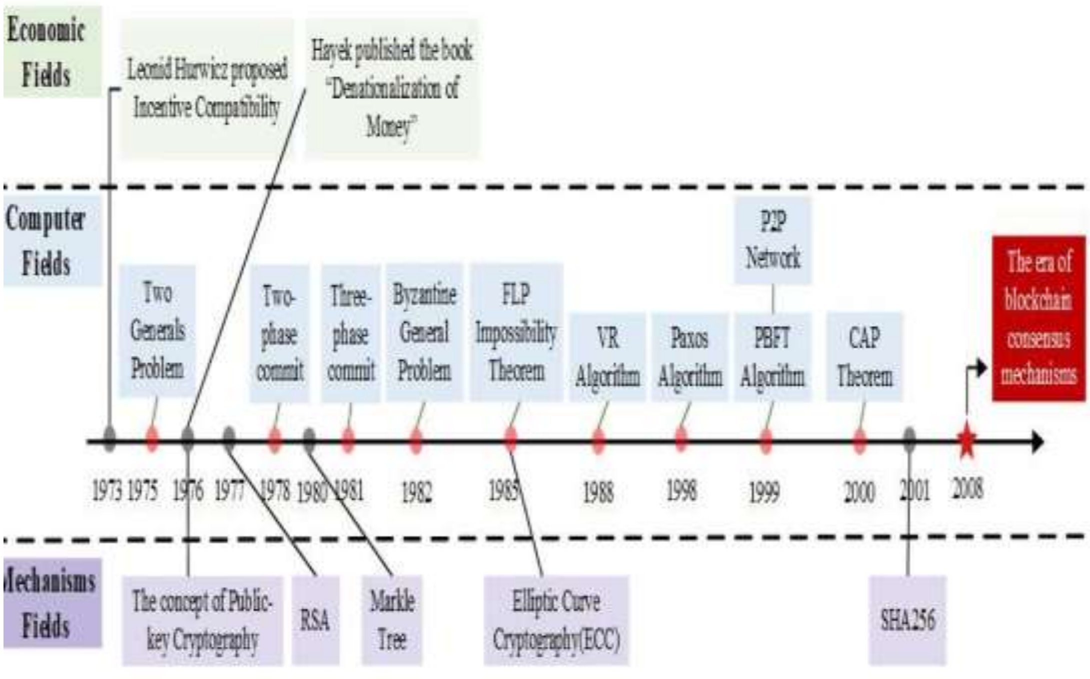

Figure 2. The theoretical bases of blockchain consensus mechanisms.

2.*4 Smart Contracts and Decentralized Applications*

A Smart Contract is a short program that can be deployed and run on a Blockchain. It reacts to transactions sent to it by executing code, and it can also hold state and funds/tokens (Ether) on the ledger. In other words, you can see it as a state machine running in the Blockchain with a public address where you can push or pull the state. Those transactions can pass both funds and data.
They are used for two purposes,
Hold funds and state, which are stored in the Blockchain under the contract's address
Run logic/code that performs actions with those funds or updates the contract's state.
For example, a smart contract for sports betting. You can create one that stores the funds/bets for a particular game and also add code for distributing the bets once you have a winner.
From an implementation standpoint, Vitalik and the rest of the crew designed a Virtual Machine for running byte code in the Blockchain, also known as Ethereum Virtual Machine or EVM. Every node in the network runs this VM, and it is ready to execute any arbitrary code. Pablo Cibraro 2017.

Decentralized Applications (a.k.a DApps)
If you consider Smart Contracts as back-end APIs running in the Blockchain, Decentralized Applications are the front-end or UX. They represent the visible layer connecting users or other applications with the Smart Contracts running in the Blockchain.

Every Ethereum node connected to the Blockchain exposes an RPC-JSON interface over HTTPS or Web Sockets that any Dapp can use to connect and submit transactions.
The only requirement is to have a client library in your language of preference that knows how to talk to that interface.
As part of this article, we will see one of the most common implementations for Javascript, Web3.js.
Running a node is not a requirement for implementing DApps. You can find private offerings in the cloud that give you access to existing Nodes. For instance, Infura provides free access for the first three DApps.
Anatomy of a Smart Contract for Ethereum
A Smart Contract is deployed as byte code, but that does not imply you will have to write it that way. You will find various high-level languages in the community that compiles and converts your code to the EVM bytecode. The most popular one is Solidity.
Solidity is an object-oriented and static language influenced by C++ or JavaScript. If you are a web developer with experience in any bracket language like JavaScript, the transition to Solidity will be easier for you. Pablo Cibraro 2017.

2.5 Security and Cryptography

Network Security protects our network and data from breaches, intrusions and other threats. This is a vast and overarching term that describes hardware and software solutions as well as processes or rules and configurations relating to network use, accessibility and overall threat protection. Network Security involves access control, virus and antivirus software, application security, network analytics, types of network-related security [endpoint, web, wireless], firewalls, VPN encryption and many more. Network Security is the most vital component in information security because it is responsible for securing all the information passed through networked computer. Network Security refers to hardware and software functions, characteristics, features, operational procedures, accountability, measures, access control, administrative and management policy required to provide an acceptable level of protection for hardware and software in a network. Internet has become more widespread, if an unauthorized person is able to get access to this network, he can not only spy on us but he can easily mess poor lives. Network Security and Cryptography is a concept of protecting the network and data transmission over a wireless network. A Network Security system typically relies on layers of production and consists of multiple components including networking, monitoring and security software in addition to hardware's and appliances. All components work together to increase the overall security of the computer network. Security of data can be done by a technique called Cryptography. Ms. Anitha and Ms. Padmalatha 2022.
Cryptography is the science of writing in secret code. Modern Cryptography exists at the intersection of the disciplines of mathematics, computer science, and electrical engineering. An application of cryptography includes ATM cards, computer password, and electronic commerce. The development of the World Wide Web resulted in broad use of cryptography fore-commerce and business applications. Cryptography is closely related to disciplines of cryptology and cryptanalysis. Techniques used for decrypting a message without any knowledge of the encryption details fail into the area of cryptanalysis. Cryptanalysis is what the lay person call "breaking the code". The areas of cryptography and cryptanalysis together are called cryptology. Cryptography means "Hidden Secrets" is concerned with encryption. Encryption is the process of converting ordinary information (called plaintext) into unintelligible text (called cipher text).

Decryption is the reverse process of encryption, moving from the unintelligible cipher text back to plaintext. Cryptosystem is the ordered list of elements of finite possible plaintext, cipher text, keys and the encryption and decryption algorithms which correspond to each key. Ms. Anitha and Ms. Padmalatha 2022.

Figure 3. Encrypting and decrypting plain text

2.6 Blockchain Platforms and Ecosystems

Blockchain came to prominence in 2009 with the launch of Bitcoin. It was the first cryptocurrency and also the first real Blockchain platform. So, you could describe a Blockchain platform meaning a platform that exists to support a particular flavour of Blockchain. If you look at any comparison of Blockchain platforms, you'll see there are many types of Blockchain platforms that address different business needs–there are even free Blockchain platforms. Mark Morley 2020.

2.6.1 Bitcoin

Bitcoin is a type of digital currency known as cryptocurrency. Although there are other kinds of cryptocurrency, Bitcoin is by far the best-known and the most widely used and discussed. The Bitcoin system is based on a decentralized peer-to-peer network. Users can pay other users directly. Secure transactions are enabled through a cryptography. A user signs his transaction with a private key to create a digital signature, which ensures authenticity. After the transaction has been confirmed, it is added to the "block chain", a ledger containing all transactions in the Bitcoin network. Then, the payment is processed via the so-called "mining" process. In that process, individual users provide computing power to process a complex block hashing algorithm to validate the transactions; users receive Bitcoins as a reward. Finally, the transaction amount is deposited in the receiver's wallet address (Hobson, 2013).

2.6.2 Ethereum

Introduced in 2013, Ethereum is one of the oldest and most established blockchain platforms. It provides a truly decentralized blockchain that is comparable to the Bitcoin blockchain network. Manders said its key strength is that it enables true decentralization with support for smart contracts. Its key weaknesses include slow processing times and higher transaction processing costs compared to other platforms. Besides its role as a blockchain platform that underpins enterprise applications, it has its own cryptocurrency called *ether*. George Lawton 2023. The Ethereum platform is seeing widespread adoption by technologists who build decentralized applications, or dApps, on the Ethereum network. For example, there are numerous platforms and exchanges for non-fungible tokens (NFTs) -- a type of digital asset that can be exchanged on a blockchain. It has a mature ecosystem of tools for writing smart contracts using the Solidity programming environment, which runs on the Ethereum Virtual Machine. However, alternative

blockchain networks can process transactions much faster at potentially lower cost than Ethereum, though many observers expect this to change after Ethereum adopts a more efficient security mechanism.
It also has an active developer community orchestrated by the Enterprise Ethereum Alliance, which has more than 250 members, including Intel, JPMorgan and Microsoft.
The Ethereum community has also migrated from a proof of work (PoW) consensus mechanism to proof of stake (PoS), which is more energy-friendly. The migration required an elaborate process to spin up a separate, new type of blockchain called a Beacon Chain that has been merged into the existing main Ethereum blockchain. The Ethereum Foundation estimated this reduces energy use by 99.95% compared to the older approach.
The community is now working on a sharing mechanism that will expand the capacity to store data, scale throughout and cut network fees. It is expected to begin rolling out in phases in 2023 and to be fully supported in 2024. (George Lawton 2023).

2.6.3 IBM Blockchain
IBM Blockchain is a private, decentralized blockchain network that has been the most successful with enterprise clients who are less risk-averse, Manders said. He has seen the biggest opportunities in using it to link into enterprise cloud and legacy technologies more seamlessly than is possible in other decentralized networks.
The IBM Blockchain developer tool was designed to be flexible, functional and customizable. IBM has also invested in creating a user-friendly interface to simplify critical tasks, such as setting up, testing and rapidly deploying smart contracts. (George Lawton 2023).

3. BLOCKCHAIN APPLICATIONS ACROSS INDUSTRIES

3.1 Finance and Banking

There are a number of key areas where companies can use blockchain in financial software and systems. While banks are reluctant to openly discuss potential uses of blockchain, a number of them have recently commissioned studies to identify exactly where they can. These include Citibank, Credit Suisse, and the World Economic Forum. (Aran Davies 2023).

Payments
Blockchain technology using digital currency could be used in both domestic and international fund transfers. While on the domestic front banks are likely to resist implementing blockchain solutions, given that they have already invested heavily in existing centralized solutions, internationally they stand to benefit enormously from such a change.
The reason international transfers stand to gain is the huge disparity between rules and regulations as well as IT systems between the banks from country to country. (Aran Davies 2023).

Remittances
The figures relating to how much of certain developing countries 'entire GDP is down to remittances are quite an eye-opener. Haiti has one of the worlds 's highest remittance vs. GDP rates, some 29% of its entire GDP.

In the Philippines, it is at just over 10% while in Mexico it is 2.7%. When put into perspective, remittances account for 0.7% of the entire world ‘s GBP each year. This is an enormous amount of money that is somewhere in the region of $1 trillion.
Traditionally, the remittance market has been dominated by MTO-model companies such as Western Union. Though banks do actually offer this service, the inherent problems of cross-border remittances, such as creating safe and secure partners where receivers can collect their money, have made many banks wary of the market. (Aran Davies 2023).

Payment gateway

Next in the list of blockchain examples for finance industry solutions is a payment gateway. A recent successful ICO by startup Mycelium brought attention to how blockchain could be used to facilitate next-generation payment systems. The company’s goal is to “bring merchants and consumers together with a blockchain card and mobile wallet.”
While the concept of cryptocurrency existed long before Mycelium, the company’s decision to use digital tokens as a way to facilitate the transfer of wealth, as well as to incorporate a payment gateway facility, generated huge interest in its ICO.
Mycelium ‘s business model makes the need for traditional bank payment processing redundant. Since users can use the Mycelium card to pay for goods and services anywhere and at any time, using decentralized blockchain technology, transactions are also safer and more secure.
Whether they like it or not, technology such as this will force the banks to undertake a major shift from traditional computer systems to blockchain-based payment gateways. Since traditional payment systems are also less secure, banks will need to make the switch in the near future. (Aran Davies 2023).

3.2 Supply Chain Management

Blockchain technology has the potential to revolutionize supply chain management by providing increased transparency, security, and efficiency. The following are 10 leading uses of the technology in the supply chain. (Sean Ashcroft 2023).

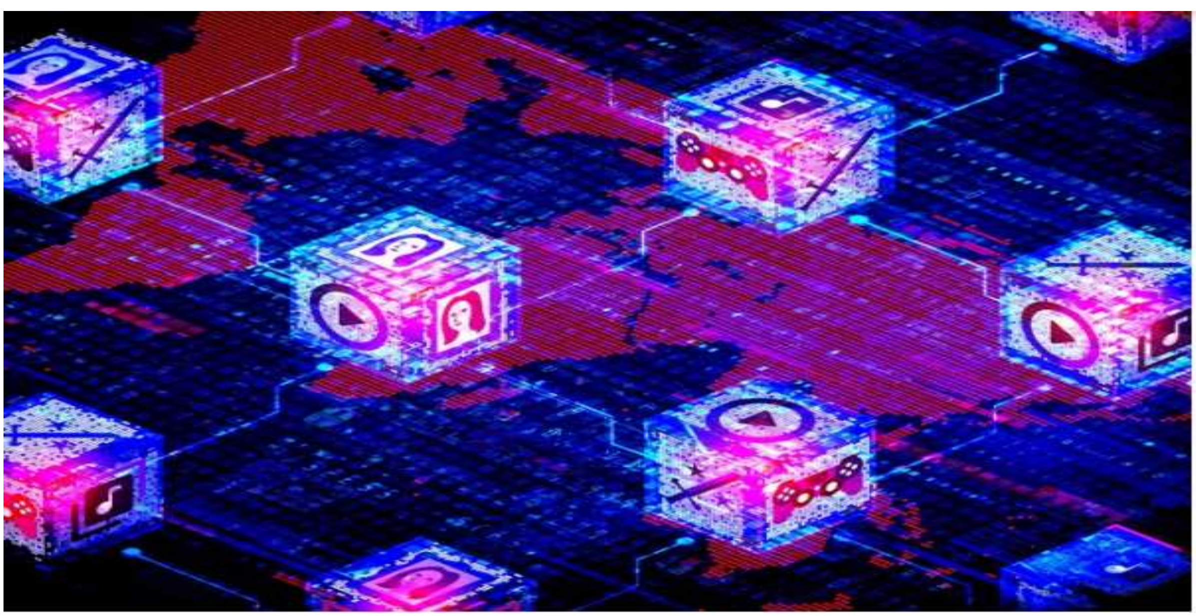

Figure 4. Blockchain in Supply Chain

Transparency
Blockchain technology can provide real-time visibility and tracking of goods and products throughout the entire supply chain, from production to distribution to end consumers. This helps to increase transparency and trust between different parties in the supply chain. (Sean Ashcroft 2023).

Quality control
Blockchain can be used to track the quality of products as they move through the supply chain, enabling faster identification and removal of defective products, reducing waste and improving customer satisfaction. (Sean Ashcroft 2023).

Finance
Blockchain can be used to facilitate supply chain finance, providing secure and transparent records of transactions between suppliers, manufacturers, and distributors. (Sean Ashcroft 2023).

Smart contracts
These are self-executing contracts with the terms of the agreement between buyer and seller being directly written into lines of code. They can be implemented using blockchain technology to automate and streamline supply chain processes, reducing costs and improving efficiency. (Sean Ashcroft 2023).

3.3 Healthcare

One of the fields where blockchain is considered to have great potential is healthcare. Understanding the pertinence and importance of blockchain in healthcare, in 2016, the Office of the National Coordinator for Health Information Technology (ONC), composed an ideation challenge for requesting white papers on the potential utilization of blockchain in healthcare. This challenge brought about a few proposed healthcare applications for blockchain. Mohamed Jmaiel, Mounir Mokhtari,
Bessam Abdulrazak, Hamdi Aloulou, Slim Kallel1(2020).

Electronic Medical Records
To transform healthcare, the focus should be attributed to the management of health data that could be improved from the potential to connect heterogeneous systems and increase Electronic Health Records (EHRs) accuracy. While Electronic medical records (EMRs) and EHRs are used interchangeably, there is a difference between the two terms. EMRs term came along first, which is a digital version of the paper charts in the clinician's office. An EMR contains the medical and treatment history of the patients in one practice. However, EHRs focus on the total health of the patient-going beyond standard clinical data collected in the provider's office and inclusive of a broader view on a patient's care. Mohamed Jmaiel, Mounir Mokhtari,
Bessam Abdulrazak, Hamdi Aloulou, Slim Kallel1(2020).

Remote Patient Monitoring

To be able to remotely monitor the status of the patient, remote patient monitoring covers the collection of medical data through mobile devices, body area sensors and IoT (Internet of Things) devices. Blockchain play an important role in storing, sharing and retrieving the remotely collected biomedical data.
In this context, Ichikawa epresent an application where mobile devices are used to transmit data to a blockchain-based application on Hyperledger Fabric.
Griggs demonstrate how Ethereum smart contracts provide automated interventions in a secure environment by supporting real-time patient monitoring application. Other proposed approaches present the great potentials of Internet of Things (IoT) in many domains, especially it's being heavily exploited and used in e-health. In this direction, Ray et al. propose IoBHealth, a data-flow architecture that combines the IoT with blockchain and can be used for accessing, storing and managing of e-health data. Mohamed Jmaiel, Mounir Mokhtari,
Bessam Abdulrazak, Hamdi Aloulou, Slim Kallel1(2020).

3.4 Education

The technical features of the blockchain are capable of inspiring a set of good solutions to the problems or issues of online education. In this paper we attempt to implement blockchain technology in the following aspects of online education.

Full record of learning trajectory

The blockchain stores data in a distributed database, and records data blocks in chronological order by timestamps. The new data blocks cannot be deleted. The cryptographic algorithm is adopted to prevent the tampering of data, adding to the difficulty in fraud. Currently, most online education platforms are decentralized, offering courses of inconsistent qualities. What is worse, the learning results lack public recognition due to the lack of a unified certification system. Unsurprisingly, online education fails to yield fruitful results. The chronological data recording of the blockchain provide a good way to record the learning data of online education. The students' learning data, including learning time, course files and test results, can be recorded on the blockchain in chronological order, and each data record can be marked with a timestamp. The data accuracy is protected by the cryptographic-based recording method, eliminates the risks like tampering or deletion. Thanks to the decentralization, distributed database and collective maintenance of the blockchain, any education platform or organization will be able to record the learning trajectories of students across regions and time. This will improve platform efficiency and reduce the hardware cost. Besides fully recording students' learning data, the blockchain-based learning record prevents tampering and deletion, offering a good guarantee to the credibility of students' learning data. At the same time, the learning data, whose reliability is ensured by the encryption technology, can be broadcasted across the network, and easily downloaded by the employer. From the blockchain-based data, the employer can learn more about the learning state of the students and verify their information. Therefore, blockchain technology can effectively avoid paper fraud, fake academic credentials and other misconduct in higher education, and establish a trusted platform for students, teaching platforms and employers. Han Sun, Xiaoyue Wang, Xinge Wang (2018).

Trusted certification of learning results

Despite the immense popularity of online education platforms, the students are not enthusiastic after learning a few courses because the learning results are neither publicly recognized nor officially certified. This is attributable to the lag in pushing forward the certification of learning results. At present, the certification for online education is conducted inefficiently by third-party agencies. This mode cannot meet the needs of the boom of online education in the future. When a student is hunting a job, his/her certificates are archived in the education platform or the school, which will be verified by the employer. If he/she loses a certificate, the student has to go through a complicated and inefficient process to obtain another copy of the certificate from the platform or the school. The blockchain technology, however, provides a simple, efficient solution to certification of learning results, especially academic certification. The students' certificates can be verified easily even if they are lost. The blockchain adopts an asymmetric encryption algorithm in cryptography to ensure the security and credibility of the data. On this basis, it is possible to design a set of learning results certification system. First, the online education platform or the issuing organization records the learning data of students based on the blockchain technology, including the basic information, the course information, the course scores, the date of issuance, etc., and encrypt the data by the private key of the platform or organization. Then, the encrypted digital certificates are issued to the students and other recipients within the network. In this case, the employer can perform Hash verification of the digital certificates using the public key of the platform or organization. Han Sun, Xiaoyue Wang, Xinge Wang (2018).

Decentralized sharing of education resources

Currently, there are many online education platforms, offering diverse courses with rich contents. Nevertheless, the courses are not shared across the platforms, due to the constraints like education mode, copyright, etc. For those learning different types of courses, the user experience is rather poor because they have to log into different platforms. Similarly, it is very difficult for students of higher learning to study the knowledge in another school or discipline. Many quality course resources are wasted because of the absence of unified and efficient utilization. With the rise of the sharing economy (e.g. shared bikes), the society is calling for better utilization of resources. In the education field, resource sharing marks the future direction of development. Blockchain technology makes it possible to realize resource sharing in online education. As a typical application of blockchain technology, smart contract is a program system developed on cryptographic security mechanism. It can complete complex transaction operations without human intervention. The system also supports automatic execution and automatic verification. Smart contract technology can simplify the transaction process, realize smart, automated and decentralized transactions and improve the transaction security. Smart contract preludes the formation of a huge resource sharing platform for online education. Based on smart contract, the online education platform can complete course purchase, settlement and acceptance efficiency and accurately without incurring any labour charges. The distributed storage and collective maintenance of blockchain allows the students to acquire the resources of different platforms by logging into only one node in the blockchain network. Furthermore, the education resource data will not be invalidated when individual nodes are damaged in attacks, which is a strong guarantee of data security. In addition, global knowledge systems like Wikipedia, research institutions, academic journals and other education data can be added to the blockchain network using blockchain technology, creating a global knowledge base. The nodes in any blockchain network can access these knowledge resources. This greatly improves the learning efficiency and enriches the learning methods. Han Sun, Xiaoyue Wang, Xinge Wang (2018).

4. **ADVANTAGES OF BLOCKCHAIN TECHNOLOGY**

4.1 Enhanced Security and Immutable Data

A database where all transactions are visible to the public is a less travelled route and is not very inviting to cybercriminals. The blockchain stores data in a highly encrypted way thanks to cryptography, which reduces vulnerability and ensures data ownership by providing a higher level of encryption. As all transactions are recorded across all nodes, hackers cannot steal, hack, or tamper with data unless a platform-level vulnerability exists. A cyberattack is a common occurrence. Every other day, thousands of users are affected by a breach of a company's data. Despite blockchain's ability to secure user data, there is the issue of the outage that results from it. Blockchain's decentralized servers ensure that the servers will continue to run uninterrupted even if an attack occurs. In addition, DOS attacks are generally not possible with blockchain technology. Gousia Habib, (2022).

4.2 Transparency and Trust

Trust, privacy and transparency are concepts found in the research streams of Blockchain technology, Asif Akram and Philipp (2018).
The definition of transparency is more ambiguous. A wider definition is provided by Ball (2009), who describes "transparency as a public value embraced by society to counter corruption, transparency synonymous with open decision-making by governments and non-profits, and transparency as a complex tool of good governance in programs, policies, organizations, and nations." (Ball, 2009, p. 293) The definition from Do Prado Leite and Cappelli (2010) that describes transparency from an IS angel regarding the disclosure of information (do Prado Leite and Cappelli, 2010). Privacy and transparency in the context of Blockchain technology are intertwined because the basic idea behind Blockchain is an open one, where transactions are anonymous and visible to everyone. However, Blockchains are not open per-se and a distinction can be made between private and public Blockchains. In the literature the terms 'permissioned' and 'permissionless' are used as well (Pilkington, 2016, Lewis, 2015, Xu et al., 2016). In a public Blockchain there are no restrictions regarding participants in the network and all transactions are identifiable by their public hash value, which is used to validate the transaction (Christidis and Devetsikiotis, 2016). A private Blockchain on the other hand, involves the monitoring of read and write permissions as well to restrict the access to the network (Pilkington, 2016). Implications of the different approaches are that private Blockchains cannot reach the same level of decentralization as public Blockchains. Due to the described system of user rights management in private Blockchain, the degree of transparency can be controlled as users are known and not anonymous. The users and their transactions of public Blockchain remain anonymous and transactions visible (Xu et al., 2016). Asif Akram and Philipp Bross. (2018).

4.3 Efficiency and Cost Savings

blockchain is being used by governments for the management of digital identities. For example, Estonia uses blockchain-based digital identity to digitize national identity records, secure citizen data, and to reduce the inefficiencies of legacy digital ID management platforms, such as high costs. Gousia Habib, Sparsh Sharma, Sara Ibrahim, Imtiaz Ahmad, Shaima Qureshi and Malik Ishfaq (2022).

4.4 Decentralization and Disintermediation.

The digital currency Bitcoin and the anonymous communication protocol Tor are prominent examples of decentralized Internet solutions that have seen successful adoption. At the same time, there is no established, standard definition of decentralization within the context of Internet-deployed systems. Decentralization is defined by Merriam Webster as "the dispersion or distribution of functions and powers". It describes the process by which decision-making is delegated away from a central, authoritative entity, for example, shifting authority from a government to provinces or municipalities within a country. Decentralization is widely used as a term within different branches of science, including economics, social sciences, and computer science. Marinus Abraham DE VOS (2021).

The functionality of Bitcoin and early cryptocurrencies is limited to the minting and transfer of blockchain-based currencies to other users. Ethereum, a blockchain solution released in 2015, was the first platform that enables developers to write and deploy smart contracts on a blockchain ledger. Smart contracts, introduced by Nick Szabo in 1990, are self-enforcing computer programs that are automatically executed and reside on a blockchain. A transaction in Ethereum can deploy a new smart contract on the blockchain or invoke a function of an existing smart contract. Users submitting transactions have to pay gas, the native currency of the Ethereum blockchain, to remunerate active miners. The amount of gas required for a transaction depends on the computations executed by the function invocation, e.g., expensive operations like encryption consume more gas. Smart contracts enable developers to build decentralized blockchain-based applications, also called DApps. The most common DApp on the Ethereum blockchain is an ERC20 contract, which enables developers to issue and manage custom assets. Besides ERC20 tokens, the Ethereum blockchain hosts almost 3'000 DApps at the time of writing, including lotteries, games, asset markets, voting, prediction markets, and decentralized lending solutions. Despite the thriving ecosystem, it is non-trivial to revoke or disable a deployed smart contract when a software bug has been exploited. In 2016, the Ethereum network almost collapsed due to implementation errors in the smart contract that managed The Decentralized Autonomous Organization. Marinus Abraham DE VOS (2021).

In many physical and electronic marketplaces, middlemen play a key role in the matching of buyers and sellers, and in the facilitation of transactions between traders. The popularity of electronic commerce and the rise of new business models has resulted in much interest to act as trusted intermediary to benefit from the interactions between traders. A well-known example of a trusted intermediary is PayPal, a payment service provider for retailers. Besides providing payment services, PayPal can also act as arbitrator when a dispute between a buyer and seller arises. The ability to act as trusted intermediaries is at the core of electronic markets and their services help to ensure that a trade between a buyer and seller who might not necessarily trust each other proceeds without issues.

Bitcoin and subsequent blockchain-related innovations have further challenged the need for trusted intermediaries. By leveraging cryptographic techniques, cryptocurrencies have demonstrated that a decentralized payment system without financial institutions is possible. Since the introduction of Bitcoin, there has been much effort by both industry and academia to critically assess the necessity of trusted intermediaries, and potentially replace them with another mechanism, e.g., using smart contracts on Ethereum Stefano Lande and Roberto Zunino (2018).

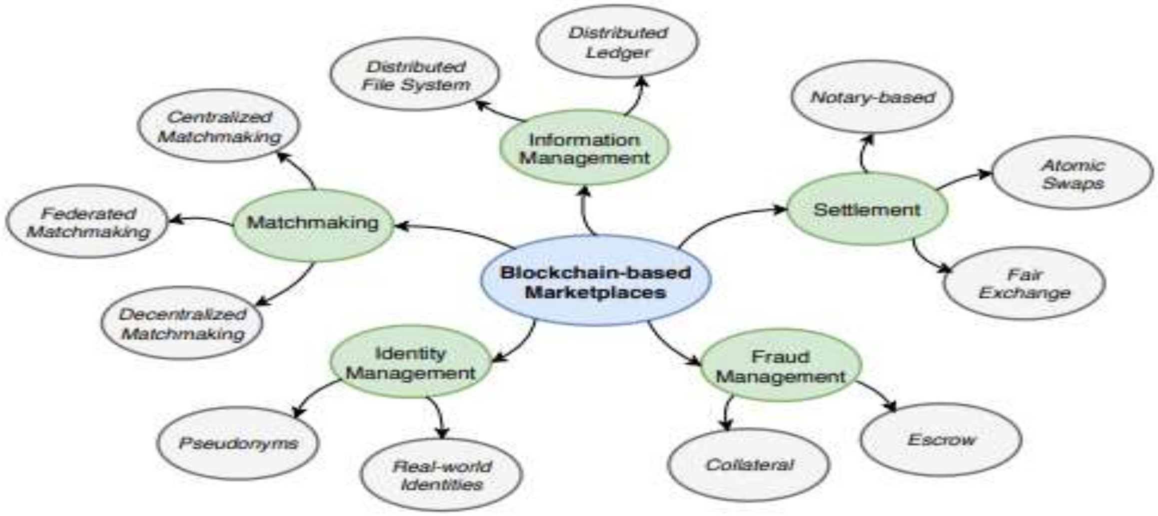

Figure 5. The five aspects of blockchain-based marketplaces (colored in green). For each aspect, we identify existing mechanisms (colored in grey).

5. CHALLENGES AND CONSIDERATIONS IN BLOCKCHAIN ADOPTION

5.1 Scalability and Performance

Blockchain was developed as a network that can enable interactions between participants without any central authority. All the participating nodes in the blockchain network have equal rights and it is reasonable to wonder how the network runs without any governing authority. Every individual node in the network has the capability to govern and manage transactions in the blockchain network.
Diego Geroni (2021).
Despite the promising factors associated with blockchain, it is difficult to develop decentralized applications for various reasons. First of all, blockchain network is vulnerable to hacks. In addition, other issues such as the requirement of additional tools and restricted usability also affect the adoption of blockchain. However, scalability remains one of the top issues for blockchain networks now.
So, why is scalability an issue for blockchain? Take the example of Bitcoin for finding the ideal answer. It processes almost 7 transactions every second while Visa processes almost 1700 transactions every second on average. You can clearly see the difference in performance between Visa and blockchain-based technology. On the other hand, you also have to deal with the problem of deploying new technology. Therefore, the unresolved concerns of scalability on an architectural level create difficulties in the adoption of blockchain and its practical applications.
Diego Geroni (2021).

5.2 Regulatory and Legal Frameworks

Javier Sebastián, Digital Regulation Manager at BBVA, evaluates the regulatory challenges that the technology still needs to overcome before it can be used in the world of financial services.
Maria Tena (2017).
*1.- **Legal framework regarding the legal nature of blockchains and shared distributed ledgers.*** This includes territoriality (issues of jurisdiction and applicable law) and liability should

something go wrong. By definition, shared distributed ledgers (or DLT) have no specific location. In terms of jurisdiction and applicable law, territoriality constitutes a problem, as each network node may be subject to different legal requirements, and there is no "central administration" responsible for each distributed ledger, the nationality of which might act as an "anchor" in terms of regulation. Following this same reasoning, liability also represents a concern, as there may be no party ultimately responsible for the functioning of distributed ledgers and the information contained therein. Javier Sebastián (2017).

*2.- **Legal framework for recognition of blockchains as immutable and tamper-proof*** **nodes**, ensuring the veracity of information contained therein. A legal framework is required for using blockchains as unique and trusted sources of identity. Before this is possible, standardized regulation is necessary on data protection and authenticating the identity of legal persons.

While there is wide consensus among the cryptographic and IT community regarding the practical immutability of blocks in a well-defined blockchain, either because it is technically impossible to modify blocks in "work test" systems or other kinds of controls linked to consensus mechanisms, there is as yet no legal recognition of this aspect of blockchains, and therefore it could not be wielded as a legal argument in court.

3.- ***Regulation regarding interpretation of the "right to be forgotten"***, as the "tamper-proof" characteristic of blockchains “clashes” with said right, granted under European regulation to protect personal data. The fact that a blockchain is immutable may represent a problem, as it might conflict with other rights recognized by politicians, governments and/or regulators. One example is the "right to be forgotten" granted to each citizen under European regulation, which allows **any European citizen the right to have information stored in external databases,** either on paper or in electronic format, **deleted should they so wish.**

The only solution to reconcile such rights with the very nature of blockchains may be to replace the right to have information "deleted" with a right to "prohibit the use" of personal information by third parties. This could be achieved by a combination of automatic data encrypting when certain conditions are in place (which could mean use of smart contracts) or alternative solutions to prevent said information being accessed when an individual decides to exercise their right. Maria Tena (2017).

5.3 Privacy and Confidentiality

The characteristics of Blockchain are decentralization, transparency, auditability, and persistency. The characteristics are attractive, but there are related side effects as mentioned in the paper Bansod S and Ragha L (2020). Though there are various challenges, this paper discusses some of the issues connected with the privacy preservation and security attacks.

(a) ***Identification*** in a decentralized and persistent environment is a very difficult task. The security and risk management aspects need further study in Blockchain environment as suggested by NIST in white paper. Fake identity, anonymous user and unauthorized entry may cause problems to identification of user and data. Hence if Blockchain-based identity is to become an ultimate architectural feature of tomorrow’s web, then mitigation measures to overcome the risk of security and privacy are to be implemented.

(b) ***Transaction linkability*** and the related address tracing are generalized issues in Blockchain. Cryptocurrency has been suffering from analysis attack of wallet address, transaction coins and

other related active attacks. Although Bitcoin is an old application, having been in use for over 11 years, these issues have not been fully resolved yet. Cryptocurrency applications ZCash and Monero are encountering attacks and are discovering the loopholes in the operations. It is found that in some cases the shielding address delinks the transparent address and also transparent address does not protect the value of transactions. Onion or Garlic cast routing is designed to be highly resistant to wide range of attacks while ensuring a high level of anonymity but these are still vulnerable to different types of attacks such as timing analysis.

(c) ***Key management or wallet*** **management** is another big challenge in Blockchain technology. Operations like generation of keys and exchange of keys are termed as Key management operations which has always been challenging for enterprises. IT organizations face challenges like Scalability, Security and Availability when trying to control and manage the encryption keys. Mechanisms like the Public Key scheme and the Ring Signature scheme provide secure keys and mix them at random to provide anonymity to the user. Tricks like change of address by the user are also risky. There are chances that the transaction owner will be identified. In the process of managing the key, if the user forgets the key used, then Data recovery becomes a major issue. Even renowned applications like uPort have not yet resolved the challenges relating to the recovery of lost or stolen keys. The various issues related to different Key management methods and Recovery schemes are discussed in paper.

(d) ***Data privacy*** One of the features of Blockchain is permanency of all information entered into the systems. Manipulation of data is impossible in the distributed network as the validity is frequently verified. But Data Protection Regulation mandates that every user must have the right to erasure and the right to be forgotten. Everyone must have the right to be deleted from publicly accessible registers, databases, and so on. While persistency is considered as a security feature, Data Protection Laws look at this feature as an intrusion on privacy and user rights. However, papers discuss the feature of deleting data of a public-private Blockchain. On-chain data deletion is a complex task but off-chain data deletion can be relatively secure. Data privacy on network and storage need special attention. Data privacy should be protected in social media as well as other forms while using different data mining or big data analytics algorithms.

5.4 Governance and Consensus Mechanisms

Several governance challenges were identified per stage. In the design stage a main challenge is the “make or buy” choice of the infrastructure (van Deventer et al., 2017). This will influence the governance on all other layers. The amount of control needed on infrastructure is dependent on the product or service, which also could directly connect to choices on institutional level (jurisdiction). Another design challenge is lack of peer review in the design phase. The Cardano protocol is born on this challenge. They want to change how cryptocurrencies are designed and developed. The Cardano protocol embraces a collection of design principles, engineering best practices and avenues for exploration, small groups of academics and developers competing with peer reviewed research (Foundation, 2019). There are governance differences in the blockchain infrastructure types. In addition, there are differences in the governance stages in blockchain projects. Finally, one can make a distinction between various governance at various layers. By making use of layers the governance complexity can be easier decomposed and described. Our framework distinguishes four layers of governance in blockchain projects; infrastructure, application, company and institutional. Olivier Rikken, Marijn Janssen and Zenlin Kwee (2019).

6. THE FUTURE OF BLOCKCHAIN TECHNOLOGY

6.1 Trends and Growth Projections

The global blockchain technology market size was estimated at USD 5.7 billion in 2021 and is extending to around USD 1,593.8 billion by 2030, poised to grow at a compound annual growth rate (CAGR) of 87.1% during the forecast period 2022 to 2030**.** Blockchain Technology Market (2022).

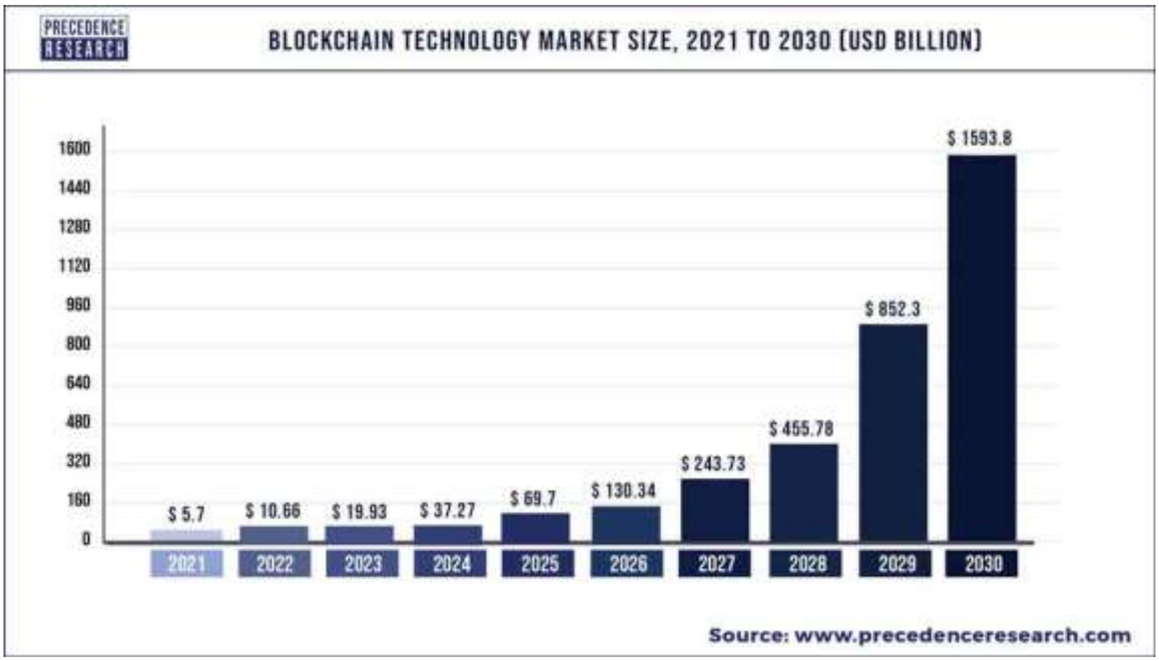

Figure 6. Blockchain Technology Market Size projection from 2021-2030.

While it took the advent of cryptocurrencies to bring blockchain technology global recognition, the world has realized its other significant applications. Emerging blockchain trends 2023 are here to drive major transformations across the global business landscape. In addition to being the backbone of cryptos, the business value-add of this sophisticated database tool is so vast that it is predicted to raise the global economy by $1.76 trillion by 2030, according to this report by PwC. Emeritus (2023).

6.1.1 Value Chains

Blockchain technology facilitates traceability across the entire supply chain. Since blockchains store data in a digital decentralized ledger, they provide instant access to the status or authenticity of a product. This enhances efficiency, ensures reliability and creates a global value chain of goods. Emeritus (2023).

6.1.2 International Trade

Smart contracts are an essential element of the blockchain ecosystem that many businesses have grown to adopt. It simplifies documents such as licenses and certificates, among others. This reduces overall costs while eliminating reliability on third parties. Additionally, it improves both speed and accuracy in the conduct of international trade. Emeritus (2023).

6.1.3 Increased Development of Blockchain-Based Applications

Software developers with blockchain expertise will be in great demand in 2023. There will be a surge in the requirement of blockchain technology that can aid in building powerful applications to carry out secure transactions, develop enhanced Know Your Customer (KYC) features and more. Emeritus (2023).

6.2 Technological Advancements and Research

Over the recent years, Blockchain technology has grown rapidly, opening up plenty of knowledge gaps for the research community. As a result, recent years have witnessed a remarkable amount of research endeavors in the domain of Blockchain (Cruz et al., 2018). Based on the data gathering method adopted in this study, Web of Science (WoS) has been alone indexing more than 7000 scientific papers in recent years. With the increasing number of publications in the Blockchain domain, comprehensive research studies are needed to investigate an overview of the current body of relative knowledge. To this end, researchers and practitioners have been provided – through a few review papers – with recent achievements and challenges regarding Blockchain (Panarello et al., 2018). Nevertheless, it has not been yet reported a systematic literature review of the recent scientific studies conducted under the domain, based on WoS as a literature database. Hence, for the steady progress in this area to be maintained, a rigorous review of the state-of-the-art in Blockchain domain is a must to explore the topic, adopting the major aim of providing another helpful guide to the Blockchain community.

There appears to be a lack of concrete, systematic reviews of the Blockchain literature in a more comprehensiveness sense. For example, some researchers preferred to solely focus on Blockchain applications within a certain domain (e.g., health-care Agbo et al., 2019, Hölbl et al., 2018, Chukwu and Garg, 2020, energy sector Andoni et al., 2019, Parmentola et al., 2021, supply chains and logistics Pournader et al., 2020, Queiroz et al., 2019, Fosso Wamba et al., 2020, industry Mistry et al., 2020, Li et al., 2019, education Alammary et al., 2019, agriculture Bermeo-Almeida et al., 2018). Others opted to discuss the QoS aspects (e.g., privacy Liang and Ji, 2021, scalability Sanka and Cheung, 2021, security Gupta et al., 2020) in the Blockchain. some of existing well-cited systematic literature reviews in this context and their contrast against the study of Ahmad G. (2023) with regard to subject area (main topic), formulation of research questions, visual representations of findings, year-wise comparisons of publication trending, and years covered in the survey. it is clear the reasons why another systematic review is necessary, highlighting how this review is different from peers in terms of the involved aspects. One of the most notables with the compared systematic reviews is that each of them is closed to the discussion of a certain main subject area and its linkage to Blockchain. For example, the studies (Wang et al., 2019, Pounder et al., 2020, Queiroz et al., 2019) discussed only Blockchain application to supply chains. Others solely addressed the use of Blockchain in the health-care domain (Agbo et al., 2019, Hölbl et al., 2018), agriculture (Bermeo-Almeida et al., 2018), business administration (Alharby and Van Moorsel, 2017, Batubara et al., 2018, Konstantinidis et al., 2018), and so on. Also, some of these reviews are limited/very limited to either proposing inclusive research questions, presenting reflective visualizations, or conducting year-wise comparisons that infer trending of the underlying subject. Ahmed G. (2023).

7. CONCLUSIONS

Blockchain Technology can already be considered as a revolutionary technology to industries and has set pace to many aspects of modern transactions. We can conclude that many Industries including the banking and finance sector have finally accept the technology and integrated in the way it will improve them. The blockchain is highly appraised and endorsed for its decentralized infrastructure and peer-to-peer nature. However, many researches about the blockchain are shielded by Bitcoin. But blockchain could be applied to a variety of fields far beyond Bitcoin. Blockchain has shown its potential for transforming the traditional industry with its key characteristics: decentralization, persistency, anonymity and auditability. Throughout this paper, we present a survey on the blockchain on how its change industries way of financial operation and the challenges it is facing. We first give an overview of the blockchain technologies including blockchain architecture and key characteristics of the blockchain. We then discuss on the application of blockchain in some industries. We also discuss on its future, trends and growth. Zibin Zheng and co. (2018) also investigate typical blockchain applications. Furthermore, we list some challenges and problems that would hinder blockchain development in brief. Nowadays smart contract is developing fast and many smart contract applications are proposed. However, as there are still many defects and limits in smart contract languages, many innovative applications are hard to implement currently. Zibin Zheng and co. (2018). plan to take an in-depth investigation on smart contract in the future to see how it can bring about more trust to the technology from industries and governments are proposed.

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