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Blockchain in Finance

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ABSTRACT

Blockchain is a digital ledger for recording transactions. It is a decentralized, distributed, and secure database that allows blocks of information to be stored in a chain. This makes it ideal for use in the financial sector, where trust and security are of paramount importance. Blockchain in banking and finance is the solution for institutions that want to truly digitize and automate their processes. Blockchain offers the promise of addressing some of the key challenges and pain points experienced over many years by the financial sector. In this paper, we explore the transformative impact of blockchain technology in various facets of the financial services industry.

KEYWORDS: *blockchain, distributed digital ledger, finance, banking, finance industry*

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INTRODUCTION

The financial services industry is an important part of the global economy, and it is essential that it functions smoothly and efficiently. The key element of the industry is trading, and trading activities are dependent on trust. Through financial instruments and strategies, trust can lead to successful businesses. The reason the financial industry is fascinated by blockchain technology is that the characteristics of the blockchain allow people to build trust faster and have the potential to change the financial infrastructure. As blockchain technologies move towards mainstream adoption, there is huge potential for financial firms to realize their benefits in guarding financial transaction data against hackers. Blockchain technology is a tamper-proof log of sensitive activities that are efficiently and securely created. It offers a decentralised system in which users can update the blockchain network [1].

The blockchain technology is not limited to the financial area. It is already disrupting various industries, including finance, healthcare, retail, insurance, and it shows no signs of slowing down. From banking and retail to gaming and entertainment, it seems like everyone is expressing an interest in blockchain technology. Blockchain facilitates major transformations in the finance industry, bringing decentralization and creating more advanced and user-friendly financial solutions. Blockchain's ability to tokenize assets, streamline cross-border payments, and facilitate real-time transactions is transforming traditional finance. Figure 1 shows the cloud word for blockchain [2].

WHAT IS BLOCKCHAIN?

Blockchain, a type of distributed digital ledger technology (DLT), is a relatively new and exciting way of recording transactions in the digital age. It is a decentralized and distributed digital ledger technology that securely records and verifies transactions across multiple computers or nodes in a network. Basically, it is a chain of blocks in which each block contains a list of transactions. The symbol of a blockchain is depicted in Figure 2 [3].The blockchain technology was created as the foundational basis for Bitcoin – a digital currency in which secure peer-to-peer transactions occur over the Internet. It is expected that the spending on blockchain solutions worldwide would grow from 4.5

billion USD (2020) to an estimated value of 19 billion USD by 2024 [4].

Originally developed as the accounting method for the virtual currency Bitcoin, Blockchains are appearing in a variety of commercial applications today. Blockchain technology is a type of distributed digital ledger that uses encryption to make entries permanent and tamper-proof and can be programmed to record financial transactions. It is used for secure transfer of money, assets, and information via a computer network such as the Internet without requiring a third-party intermediary. It is now being adopted across financial and non-financial sectors. As a catalyst for change, the Blockchain technology is going to change the business world and financial matters in major ways.

The first Blockchain was conceived in 2008 by an anonymous person or group known as Satoshi Nakamoto, who published a white paper introducing the concept of a peer-to-peer electronic cash system he called Bitcoin [5,6]. Bitcoin and Ethereum are the first two mainstream blockchains. Other modern blockchains include Namecoin, Peercoin, Ether, and Litecoin. Figure 3 shows features of blockchain [7].

Blockchain combines existing technologies such as distributed digital ledgers, encryption, immutable records management, asset tokenization and decentralized governance to capture and record information that participants in a network need to interact and transact. As illustrated in Figure 4, a complete blockchain incorporates all the following five elements [8]:

- *Distribution:* Digital assets are distributed, not copied or transferred. A protocol establishes a set of rules in the form of distributed mathematical computations that ensures the integrity of the data exchanged among a large number of computing devises without going though a trusted third party. A centralized architecture presents several issues including a single point of failure and problems of scalability.
- *Encryption:* BC uses technologies such as public and private keys to record data securely and semi-anonymously. Completed transactions are cryptographically signed, time-stamped, and sequentially added to the ledger.
- *Immutability:* The blockchain was designed so these transactions are immutable, i.e. they cannot be deleted. No entity can modify the transaction records. Thus, Blockchains are secure and meddle-free by design. Data can be distributed, but not copied.
- *Tokenization:* Value is exchanged in the form of tokens, which can represent a wide variety of asset types, including monetary assets, units of data or user identities.
- *Decentralization*: No single entity controls a majority of the nodes or dictates the rules. A consensus mechanism verifies and approves transactions, eliminating the need for a central intermediary to govern the network.

Bitcoin and its underlying blockchain technology increasingly impact all facets of society. Bitcoin's status as digital gold is merely the tip of this technology. Figure 5 shows Bitcoin [9], while Figure 6 shows how blockchain works [10]. Although blockchain technology will for all time be associated with Bitcoin due to their common genesis, it has broader applications. Cryptocurrency will increasingly become a factor in family law issues as well.

A blockchain is a tamper-proof, distributed database that stores blocks of information for cryptographically bound transactions via peer-to-peer networks. At the heart of blockchain's functionality is cryptographic hashing. Each block in a blockchain contains a cryptographic hash of the previous block, creating an immutable chain of blocks. If anyone attempts to tamper with the data in a block, it would alter the block's hash. This would disrupt the entire chain, making it virtually impossible to manipulate. The security feature ensures data integrity and prevents unauthorized changes [11].

In a nutshell, blockchain technology involves three basic concepts [12]: (1) It is a system for recording a series of data items (such as transactions between parties); (2) It uses cryptography to make it difficult to tamper with past entries; (3) It has an agreed process for storing copies of the ledger and adding new entries (also called a consensus protocol).

Blockchain is a novel decentralized infrastructure and distributed computing paradigm that uses a chained data structure for verification, storage, and distributed consensus algorithms to generate and update data. Decentralization is a key feature of blockchain technology, which refers to the distribution of power and decision-making across a network of nodes or participants rather than being controlled by a central authority or system. It provides robustness while eliminating many-to-one traffic flows to avoid delays and single points of failure. The advantages of decentralized property of blockchain network include the following [10]:

- The decentralized property of blockchain makes it less prone to failure and more expensive for hackers to attack the network.
- There is no third-party involvement; therefore, there is no added risk.
- Every change made in the network is traceable and concrete.
- Users maintain full autonomy of their properties and are not dependent on third parties to maintain and manage their assets.
- It provides enhanced security.

Figure 7 shows different applications of blockchain [11].

BLOCKCHAIN IN FINANCE INDUSTRY

Blockchain technology, the inception of digital currency, has been one of the most powerful forces driving the change in the finance industry. It is poised to revolutionize the way financial transactions are conducted, ultimately leading to improved efficiency, reduced costs, and enhanced security. From streamlined cross-border transactions and decentralized finance to asset tokenization and smart contracts, this tamper-proof, decentralized ledger technology has improved efficiency, reduced cost, and enhanced security for financial transactions. Figure 8 shows a representation of blockchain in finance [12].

Financial institutions are exploring how to fully benefit from or deploy blockchain: identifying product opportunities and assessing risks. Some of the ways blockchain solutions have changed the contemporary financial markets include [13]:

- Unprecedented security measures to ensure data integrity, restrict unauthorized access, and enhance fraud prevention.
- Enhanced transparency, visibility, and auditability in financial records and reporting.
- Faster, cheaper, and more efficient direct transactions between cross-border parties.
- Enhanced democratized investment opportunities with asset tokenization.
- Automated and efficient contract enforcement with self-executing smart contracts.

Blockchain truly has the ability to shake the multi-trillion dollar financial industry to its core. It subverts institutions in a way that makes today's current financial industry appear archaic. It is no surprise the powers that be in the world of finance are looking for their seat at the table.

APPLICATIONS OF BLOCKCHAIN IN FINANCE INDUSTRY

Blockchain has been successfully used for a variety of applications in the financial sector, including cross-border payments, KYC (know your customer) verification, and asset management. Some of the use cases of blockchain in finance are displayed in Figure 9 [14]. Common areas of application include the following [14-17]:

- *Fintech:* Financial technology (fintech) is the "marriage" between technology and finance. Fintech has impacted the traditional financial industry. Researchers have identified fintech as a technology enabler of finance industry. The economic, financial, and business and management areas are the most popular research areas related to fintech.
- *Banking:* Banking is likely an area that can benefit the most from fintech. As a rule, banking operations such as getting a loan or a mortgage, or even processing payments are slow and frustrating. Also, there are always intermediaries necessary to collect all papers, stamps, signatures, and whatsoever. Instead of facing the challenges that come with traditional money transfers, banks can leverage the blockchain technology and use it as a key differentiator to gain a competitive advantage. Today, customers prefer to manage their banking activities through digital banking from the comfort of their homes. Banks can leverage smart contracts to facilitate repetitive operations and payments, making the overall workflow go smoother and a way faster. Some experts believe that blockchain will eventually replace traditional banking systems.
- *Accounting:* Accounting, bookkeeping, and auditing are the most integral practices of a financial institution. These processes still rely on a manual workforce and include too much paperwork. By using blockchain to optimize these processes, financial institutions can reduce costs and save time. Blockchain has the potential to simplify all recordkeeping with its distributed base. However, it also can have a significant impact on auditing. Since auditors go through the process of verifying accounts and finding inconsistencies, the procedure can get rather cumbersome and time-consuming. With blockchain, everything is simplified. By adding records directly into the ledger, data is stored and updated much more efficiently.
- *Smart Contracts:* Perhaps the most impactful application of blockchain in finance is its ability to efficiently establish trust through smart

contracts. Blockchain provides an additional layer of protection in the form of smart contracts, which enable automatic transactions when certain requirements are met. Smart contracts are self-executing contracts that can be used to automate a variety of financial transactions. A smart contract is a digital contract that is stored on the blockchain. It can be used to automatically execute transactions when certain conditions are met. This would remove the need for a middleman, such as a bank, and make the process much faster and more efficient. Blockchain smart contracts can automatically perform regular audits. There are already a number of blockchain-based smart contract platforms in development, such as Ethereum and EOS.

- *Real Estate:* Completing real estate transactions usually involve various face-to-face encounters, discussions, and contract signing. As you may guess, thanks to blockchain, it no longer has to be that way. Smart contracts are already revolutionizing real estate's financial transactions with their recording and property ownership transfer capabilities. With the help of a smart contract, individuals do not have to involve any third parties like lawyers, brokers, or banks to complete their transaction.
- *Insurance:* Insurance is an area that is often subject to fraud. Property and casualty insurance claims are prone to fraud and claim assessments. Claim settlements can take a long time and eventually drive away customers. Luckily, blockchain can streamline the entire processing time and simplify claims management. Smart contracts come into play and automate settlement processes and insurance payments. The biggest pain point for both buyer and seller in the insurance sector is the claim and verification process. By using smart contracts and its distributed ledger technology, blockchain can speed up the claims and verification process, lower costs, and reduce fraud.
- *Tokenization:* This is a process of digitally representing an existing real-world asset on the blockchain. It is the process of converting assets into digital tokens within the blockchain. Blockchain also enables real-world assets to be tokenized, which in turn enables fractionalized ownership. This blockchain-based tokenization process has unlocked a wide array of unique use cases and created new products for financial institutions. The tokenization process is expected to provide greater liquidity to illiquid assets, ensure greater participation of retail investors, and simplify the compliance process for the underlying assets. Non-fungible tokens (NFTs) provide financial markets with a tool to represent physical assets on a blockchain.
- *Asset management:* The traditional approach to asset management is slow and complicated since it involves numerous intermediaries. Blockchain tackles this downside by enabling stakeholders to manage their digitized assets directly, with no external assistance. Besides, thanks to smart contract, recurrent asset management operations such as compliance and regulatory reporting can be automated. Blockchain-based asset management platforms, such as Polymath and Harbor, are already being developed. These platforms aim to provide a more efficient and secure way to manage assets, such as stocks, bonds, and real estate.
- *Payments and Fund Transfers:* One of the most significant applications of blockchain technology is in streamlining payment systems. Blockchain has the potential to transform centuries-old mechanisms for transferring money. Traditionally, payments and fund transfers are executed by middlemen, which causes extra expenses. Payments made on blockchain are peer-to-peer operations, meaning instantaneous settlement and no extra spendings. Given that blockchain can be used in both domestic and international payment, most banks have started keying into the idea of using blockchain for payment. One of the most obvious use cases for blockchain in financial services is cross-border payments. At present, cross-border payments are slow, expensive, and often involve a complex web of intermediaries.
- *Trade finance:* Trade finance refers to the infrastructure, processes and funding that support international trade supply chains. It deals with transactions linked to domestic and international supply chains. The processes behind these operations have become outdated long ago with important data still being stored in paper format. This causes major security vulnerabilities and results in human mistakes. Blockchain makes trade finance operations secure and efficient by digitizing every bit of the supply chain lifecycle — both assets and papers.
- *Blockchain-as-a-Service (BAAS):* The cloud-based service that enables users to develop their own digital products by working with blockchain, BAAS, has been widely accepted and utilized by a huge number of big companies such as Amazon and Microsoft.

- *KYC Verification:* KYC (know your customer) verification is another potential use case for blockchain in financial services. At present, the KYC process is slow and cumbersome. It often involves filling out lengthy forms and providing a large number of documents. Blockchain-based KYC platforms are being developed to streamline the process. These platforms use smart contracts to automate the verification process.

BENEFITS

Blockchain technology's features, such as distributed ledger, immutable records, real-time payments, transparency, and security, can potentially solve various existing inefficiencies of the financial system. It has actively revamped the finance industry, successfully combating obsolete elements such as numerous middlemen, long settlement time, and inefficient document management. The main blockchain benefits for banks is that it provides the level of security and accessibility any financial institution could wish for. Blockchain enhances the speed and security of financial transactions. Other benefits include the following [15]:

- *Automation:* Automation is a major benefit; smart contracts enable the automation of tedious processes, such as compliance checks, which means less paperwork to deal with. Banking giants such as JP Morgan Chase, Goldman Sachs, Citigroup, Barclays, and Royal Bank of Scotland have caught on to this trend and have started experimenting and partnering with blockchain tech companies to automate their banking functions.
- *Security:* The first priority for any financial body is in the area of security. With increasing digitization, financial institutions have become more vulnerable to cyberattacks. Cyberattacks are considered the biggest threat to the financial industry. Currently, the financial industry is quite centralized and transactions have to go through various intermediaries to be carried out. This not only creates bottlenecks and data safety risks but also contributes to a lack of transparency within the system. Since the blockchain technology is distributed, it provides more opportunities for secure workflows than traditional systems that are more vulnerable to hacking attempts. Any activity made on blockchain is permanently fixed on the ledger, so no one can make changes or remove anything discreetly. Blockchain averts security breaches by eliminating a single point of failure in a centralized financial institution.
- *Interoperability:* The technology supports interoperability between private and public chains, offering each enterprise solution the global reach, tremendous resilience, and high integrity. With blockchain interoperability, financial institutions such as banks will be able to share information, and other data across to other financial substations, in the most secured of ways.
- *Decentralization:* One of the main advantages of blockchain is that it is decentralized, meaning that it is not controlled by any one central authority. This is a key advantage over other technologies in the financial services industry which are often centralized, such as banks. Since there exists no central authority controlling the blockchain system, the likelihood of a single point of failure is reduced. This can help mitigate the impact of an individual institution's collapse on the overall financial system.
- *Immutability:* Another key advantage of blockchain technology is that it is immutable, meaning that once something has been written to the blockchain it cannot be changed. This is a key advantage in the financial services industry where data integrity is crucial.
- *Transparency:* The use of blockchain in finance eliminates or decreases the need for intermediaries' involvement. That way, it helps elevate the transparency between financial institutions and improve regulatory reporting. Its transparent and immutable ledger makes it easy for different parties in a business network to collaborate, manage data, and reach agreements.
- *Reduced Costs:* Intermediaries like financial advisors, brokers, agents, and others, all charge fees for their services. Thus, once middlemen are removed, you significantly reduce operational costs.
- *Lower Risks and Errors*: Another benefit of using blockchain in banking and finance is the ability to control risks and reduce errors. As there are fewer intermediaries involved in the process and any data is recorded, there are fewer chances to face any errors made by humans and more ways to trace and handle them.
- *Efficiency:* Blockchain eliminates the need for middlemen. However, besides reducing costs and improving security, it also leads to much higher efficiency. There is no longer any need to spend time dealing with intermediaries and waiting for them to get everything in order. Instead, things can be carried out way faster.
- *Data Integration:* In traditional banking and finance systems, there is no scope for

interoperability and data integration. The data is stored in one central database, and sharing of the data with another party can only be done manually, which takes time and is prone to human error. Blockchain provides financial institution an option to share information with other stakeholders.

- *Faster Payments:* Blockchain, using its real-time payment technology, can transform both domestic and international payment systems. Cross-border payments generally could take 2-7 business days and up to 15 % of fees to transfer a sum of the amount. Whereas, blockchain is a global ledger that is not constrained by borders and does not require middlemen.
- *Credit Reports:* Third-party credit bureaus create credit reports. Current issues in the credit reporting system are that it involves a third party, it is insecure, lacks transparency, and is prone to error. By using blockchain, consumers will not have to rely on these inefficient credit rating agencies and will have complete control over their personal data.
- *Financial Inclusion:* Blockchain technology has the power to promote financial inclusion and drive economic growth, ultimately benefiting businesses, individuals, and society as a whole. It promotes financial inclusion by expanding access to financial services for the unbanked and underbanked populations.
- *Paper Currency Replacement:* If the world is to move away from physical currency (paper bills and metal coins) and the problems and inefficiencies associated with it, it will likely need a distributed network like blockchain to make that happen.

Some of these benefits are illustrated in Figure 10 [15].

CHALLENGES

Although blockchain creates opportunities in many sectors, there are risks and challenges related to successful chain implementation. Some challenges have arisen, such as scalability, security, privacy, latency, etc. Technical challenges include limited space, less network performance, lack of universal protocols and standardizations, and high-energy consumption. Financial firms can find themselves overwhelmed by the potential complexity of blockchain. Insurance firms face a huge challenge in keeping up with the pace and complexity of regulatory change. The development of blockchain is not mature yet. Other challenges include the following [12,18]:

- *Privacy:* Ensuring a high-level of security and privacy has become very important. Blockchain technology can create permanent and immutable records for participants, but it also increases the privacy risks of some entities. It provides market-leading tools for granular data privacy across every layer of the software stack, allowing selective sharing of data in business networks. This dramatically improves transparency, trust, and efficiency, while maintaining privacy and confidentiality.
- *Scalability:* One of the primary challenges of blockchain is its limited ability to scale, as the increasing number of transactions can lead to network congestion and slow transaction processing times. The blockchain becomes voluminous with the increasing number of transactions. Blockchain transaction takes some time to implement due to their complexity, encrypted, and distributed nature.
- *Interoperability:* The lack of standardization and interoperability between different blockchain platforms can hinder seamless communication and data exchange between various systems in the financial services industry.
- *Decentralization:* The decentralization aspect of blockchain creates difficulty for governments and central banks. Since authorities cannot fully supervise assets like Bitcoin, some feel their control is threatened with this innovation.
- *Lack of Regulations:* Currently, the blockchain technology is rather new and regulation is non-existent in some countries. Everyone is just in the process of figuring it out. If you intend to build a blockchain tool for your finance company, you need to review the specific regulations in your country.
- *Regulatory Compliance:* The financial services industry is subject to a myriad of complex regulations, making regulatory compliance a significant challenge for institutions. Blockchain technology can facilitate compliance by providing a secure, transparent, and tamper-proof record of transactions, making it easier for regulators to monitor and audit financial activities. The rapidly evolving blockchain landscape can create uncertainty in terms of regulations and legal frameworks, making it challenging for financial institutions to ensure compliance and navigate the complex regulatory environment.
- *Legacy System:* Core banking comprises of transaction, loan, mortgage, and payment services. Many of these services depend on legacy

processes of execution. Traditionally, the financial services industry is known for its legacy systems, and some banks have loads of legacy systems, some of which are 20+ years old. Integrating blockchain solutions with existing legacy systems can be challenging, as it may require significant changes in the infrastructure, workflows, and processes.

- *Energy Consumption:* Proof-of-work (PoW) consensus mechanisms, used by some blockchain networks like Bitcoin, consume significant amounts of energy, raising environmental concerns. The execution and storage costs of big data programs can be higher than the long-term storage costs of electronic money transfers and transaction data. The computing power needed to run blockchain is rapidly growing. The bitcoin system consumes an enormous level of electricity.
- *Resistance to Change:* Blockchain adoption may face resistance from stakeholders within the financial services industry, as it may disrupt existing business models and require considerable investments in terms of resources, technology, and personnel.
- *Skill Gap:* There is a shortage of skilled professionals with expertise in blockchain technology, making it challenging for financial institutions to build, implement, and maintain effective blockchain solutions.

CONCLUSION

Blockchain has become a widely used information system technology recently because of its effectiveness as an intermediary-free platform. As a revolutionary technology invention after the Internet, blockchain enables new online businesses to acquire and gain the trust of stakeholders for data transactions. Often hailed as the backbone of digital currency, the technology has steadily evolved to become a disruptive force in the financial services industry. It is evident that blockchain technology will transform the financial industry for good.

As the financial services industry continues to adapt to the digital era, the adoption of blockchain technology will play a critical role in shaping its future landscape. Although there are challenges, like the talent gap and a lack of a standardized regulatory framework, blockchain is set to shape the future finance landscape with innovations like green finance, decentralized finance, and much more. The future of blockchain in finance seems quite bright as it is gaining more and more traction every day. More information on the integration of blockchain technology in finance is available from the books in [19-26] and a related journal: *IEEE Blockchain.*

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Figure 1 The cloud word for blockchain [2].

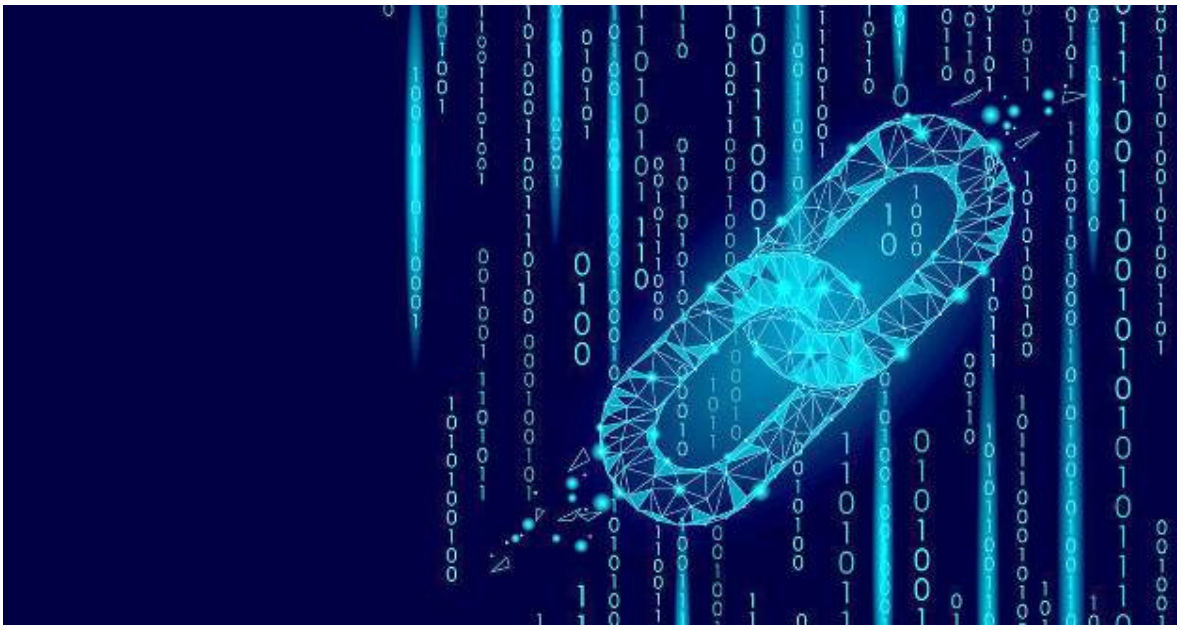

Figure 2 The symbol of blockchain [3].

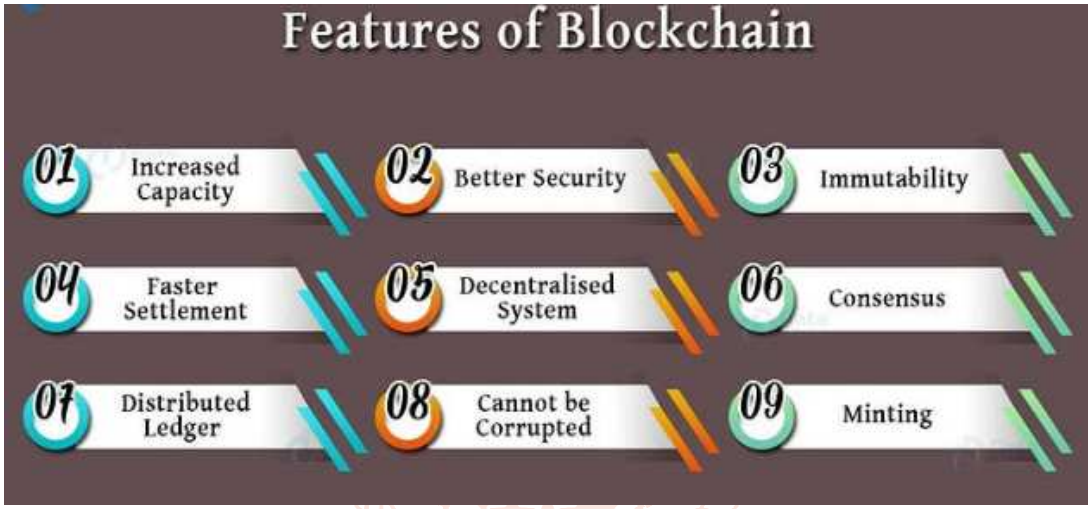

Figure 3 Features of blockchain [7].

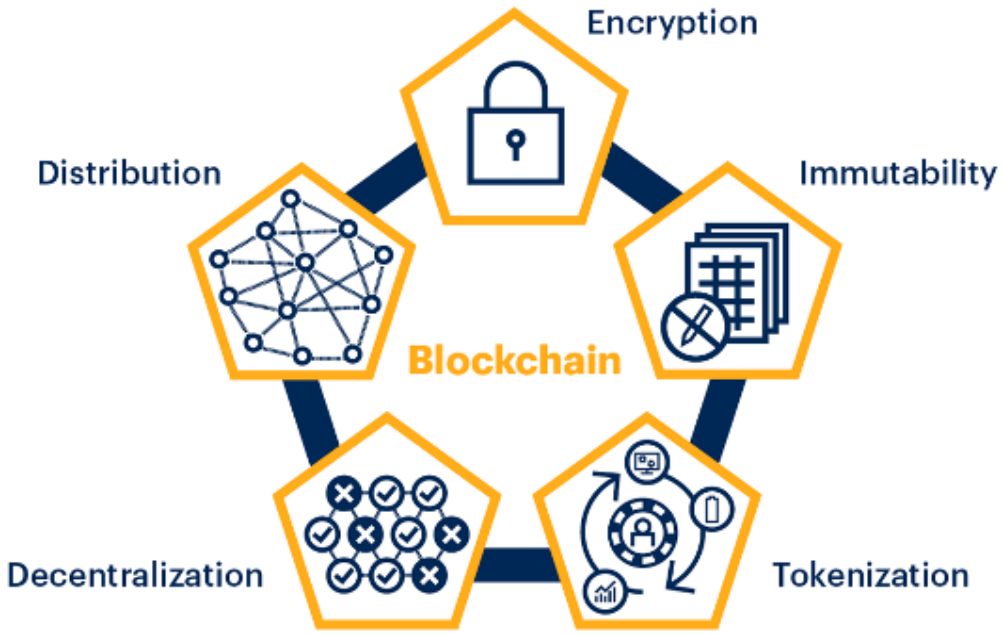

Figure 4 Five key elements of Blockchain [8].

Figure 5 Bitcoin [9].

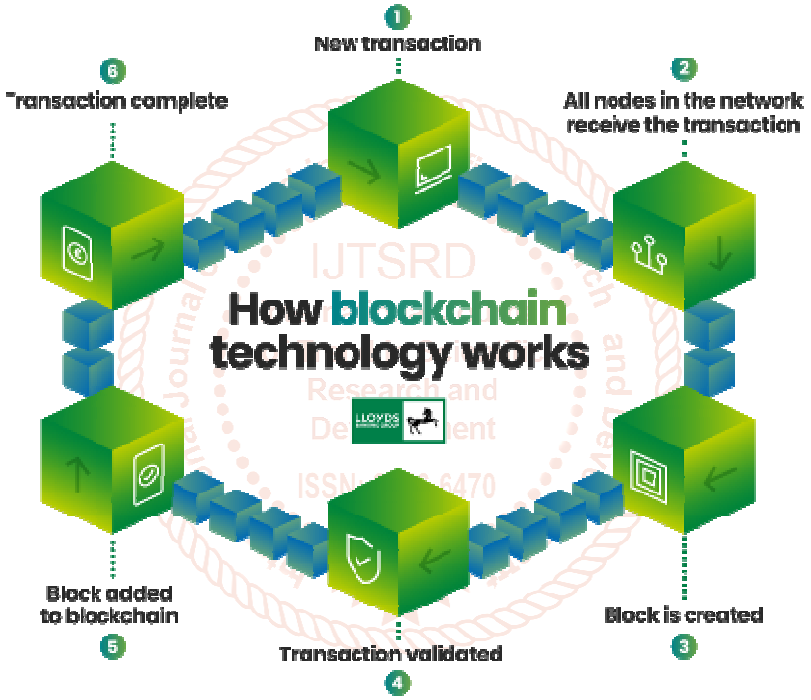

Figure 6 How blockchain works [10].

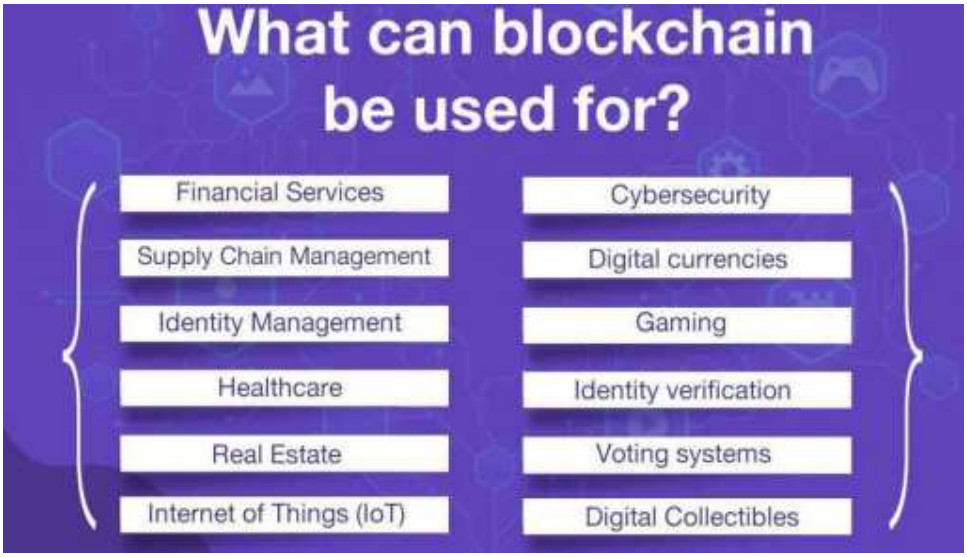

Figure 7 Different applications of blockchain [11].

Figure 8 A representation of blockchain in Finance [12].

Figure 9 Some use cases of blockchain in finance [14].

Figure 10 Some benefits of blockchain in finance [15].