Blockchain Technology: Developers Cultivate Novel Applications for Societal Benefits

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Abstract Blockchain, a buzz word in the second decade of the current century, is a decentralized technology enabling facilitation of distributed ledger with immutable transactions, updated time-to-time at every node. The beauty is such an absence of centralized authority, transactions, or digital assets that can be shared across a P2P network. This technology was conceived way back in the 90s by a group of researchers. Though the primary aim was for time-stamping documents, after two decades, in 2009, the first blockchain, i.e., bitcoin came into the market and soon became the talk of the time. Other popular cryptocurrencies in blockchain such as Ethereum, Litecoin, Ripple, and Stellar also emerged in the form of intangible currencies working on the very principle of cryptography. These days, Ethereum has become more popular since it is featured prominently for "smart contracts" for decentralized and self-executing agreements. There are so many advantages of blockchain over the traditional system. Blockchain is enriched by its dominating characteristics such as decentralized, distributed, secure and faster, transparent, immutable and insusceptible to tampering. Every node in blockchain can propose new transactions, to validate this transaction consensus mechanism play a crucial role in a structured way, i.e., proof of work and the proof of stake mechanism. Thus in a nutshell blockchain is a cutting-edge technology that proves it is time-saving, cost-saving, and rigid security. It is also advantageous over inefficient, expensive, and vulnerable transactions. It creates resistance against fraud, cybersecurity attacks without involving centralized authority. Moreover, it is secure with a cryptographic shield that contains a hash function, public-key cryptography, and digital signatures, and so on. Though phenomenal growth of blockchain in various applications like cybersecurity, supply chain, online data storage, networking, IoT, insurance, government, multimedia, and real estate is witnessed, few domains remain untouched by developers and tech savvies. The sole aim of this chapter is to focus on such untouched domains, besides showcasing the evolution of this novel platform. This chapter aims to cover the basic essence of

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blockchain with basic architecture and working principles. The societal applications will be dealt with in-depth. The chapter will present a lucid flow of the blockchain technology details with the potential for further exploration.

Keywords Blockchain · Digital asset · Peer-to-peer network · Smart contract · Ethereum

1 Introduction

Blockchain has become synonymous with banking, investing, cryptocurrency, and so many other domains of business especially in the span of the last decade. The blockchain evolved from the bitcoin network is known for the key attributes mainly distributed, decentralized, and being used as a public ledger. Blockchain innovation is creating noteworthy enthusiasm over a wide scope of enterprises in India. As the field of utilizations for blockchain develops, industry pioneers are modifying and fitting the innovation to fit different use cases. The basic notion of the blockchain has been as diverse as the basic technology itself which is expressed as the chain of blocks wherein the blocks, i.e., digital information is stored in public databases viewed as a chain. Scholarly literature covers define blockchain in a variety of ways [1]:

The main attributes of the dimensions of blockchain technology are as shown in Fig. 11.1.

- Digital, public ledger that records online transactions
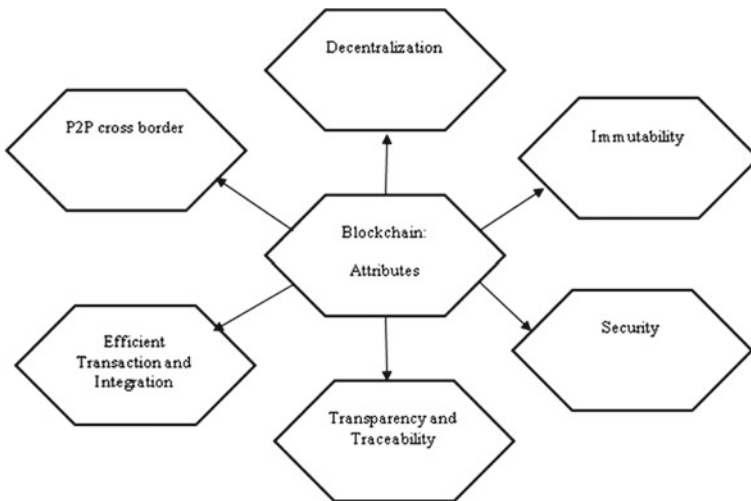- Cryptocurrencies like bitcoin

Fig. 11.1 Key attributes of blockchain technology

- Integration of a cryptocurrency through encryption, validation, and recording of transactions
- Openness as well as accessibility to the user [2].

1.1 Blockchain: Key Attributes

(a) Decentralization
(b) Immutability
(c) Security
(d) Transparency
(e) Traceability
(f) Efficient transactions
(g) Simpler integration
(h) P2P cross-border transfers.

Yet another fundamental revelation of the blockchain expressed in its basic definition is in the form of distributed ledger that marks permanent and most secure transactional data record by the way of its functioning as a decentralized database deployed on many servers in a peer-to-peer (P2P) network, each of them maintaining a copy to mitigate a single point of failure (SPOF). The beauty of the entire interface is simultaneous updating and validation of the records [3].

As a companion peer-to-peer arrangement joined with a dispersed time-stamping server, blockchain databases can be managed autonomously. There is no requirement for a different executive. As a result, the clients are the administrators. The distributed ledger technology that began with bitcoin is quickly turning into a publicly supported framework for a wide range of checks.

At present, the team has effectively gone live with blockchain applications which have been instrumental in demonstrating the plausibility and pragmatic advantages of executing blockchain. One such important execution was for a crowdfunding application for a social government assistance organization that was created utilizing the Ethereum stage empowering the application to get straightforward, changeless, and fabricate upgraded trust in the framework. Another arrangement that has been generally welcomed is birth and death registration utilizing blockchain for a district in West Bengal which improved, security and made it a misrepresentation free framework, making more prominent trust in administration applications. Blockchain has additionally been utilized as an apparatus for making more noteworthy network commitment and support in one of our tasks which included tokenizing web-based life movement. The group has additionally dealt with a pilot for Land Title Mutation in blockchain utilizing hyperledger fabric, which has planned to mechanize the procedure of land procurement and make an unchanging review preliminary.

Then again, the group is working on new use cases to infiltrate new markets utilizing blockchain. A portion of these utilization cases incorporate shared (P2P) banking arrangements, drug traceability, controls framework (blockchain evaluating apparatus), bank guarantee applications, to give some examples. We are on

a consistent post for new regions where blockchain can take care of the current issues or improve the current design. After covering the basic concepts regarding the blockchain technology, it will be logical to portray its advantages.

1.2 What Are the Key Advantages of Blockchain?

Blockchain innovation has a couple of key focal points over our present framework, which incorporates the way that it is above all else, decentralized, implying that there is no overseeing body over it. It is additionally totally straightforward and can be extremely simple to review or follow, in addition to it is liberated from information adjustment or altering. Also, the blockchain's information is scrambled, making it exceptionally difficult to hack into.

1.3 What Challenges Does India Face with Blockchain Tech Adoption?

While the eventual fate of blockchain appears to be splendid and promising, it is as yet viewed as in its early stages, with an excessive number of unanswered inquiries concerning how powerless blockchain applications and blockchain application improvement can be. Despite this, India is as yet pushing ahead with its appropriation and right now have the accompanying diligent difficulties with it. The Indian government does not have any characterized guidelines on distributed ledger technology or any guideline identifying with blockchain innovation. This absence of guidelines implies that there is an absence of consistency, making appropriation moderate. For there to be a fruitful verification of ideas for a huge scope, blockchain specialists must be recruited. In addition to the fact that this is costly current testing on blockchain applications is confined to cryptocurrency as it were.

For open-based or public-based blockchain applications, the expense of the system upkeep and the approval of the exchanges is not characterized to a particular individual, organization, or association.

Due to the innovation despite everything being viewed as new and the way that there is an absence of mindfulness about it, it implies that numerous potential merchants are not at the selection point yet. More digitization about blockchain innovation needs to happen first. From being executed, if there is to be a speedy acceptance of blockchain applications and the innovation, all in all, there should be more mindfulness spread and unmistakably characterized guidelines set up.

1.4   Wrapping It Up: Blockchain Adoption Can Solve Major Problems in India

If blockchain chain innovation was to be adopted in India, regardless of whether it is in the financial area, in the security division, or even over the medicinal services framework, it is ready to be progressive. Lamentably, India's economy experiences some extreme issues like information penetrates, budgetary record altering, and defilement, all of which might be moderated somewhat with bigger and adaptable blockchain application advancement. With the very nearly 20,000 blockchain designers arranged in India, the nation can turn into a pioneer where the blockchain is concerned.

The crucial property of the blockchain, which makes it so amazing, is unchanging nature. If one can envision a widespread record in the cloud which is shared by the individuals who reserve the options to get to, any section in the record gets included in the type of an extra block which must be confirmed by all members. That is the reason it is so troublesome if not out and out outlandish for programmers to get through the whole chain to get agreement from all members.

In the beginning it is generally accepted that the principal executive of present-day blockchain innovation originated from Satoshi Nakamoto. In 2008, an individual or gathering of individuals distinguished as Nakamoto distributed a paper, "Bitcoin: A Peer-to-Peer Electronic Cash System," which speculated a direct online payment starting with one party then onto the next without the utilization of a go-between outsider. The paper depicted an electronic payment framework dependent on cryptographic confirmation rather than trust [4].

The paper looked to take care of the issue of twofold or double spending. That is the very idea of digital cash which permits it to be effortlessly copied and spent more than once. The subsequent vulnerability was lethal to the appropriation of the innovation. The Nakamoto paper tackled this issue by connecting each exchange to the exchange going before it in an altered safe way. The tamper-resistant way portrayed by Nakamoto was the open record. With this record, a system can look at the exchange history of an electronic coin that a client submits for payment and can affirm that the coin has not as of now been spent, accordingly forestalling the "double spending" issue. Blockchain is a kind of database that is copied on numerous PCs or "nodes." All of the nodes have similar data on them. This is imperative to the achievement of the blockchain innovation. The data is put away in, as the name suggests, blocks. Each block can contain various exchanges, with every exchange having an interesting reference number, a time stamp, a pointer to the quickly past exchange, just as data on the exchanges themselves. Along these lines, every hub approaches every single past square down to the primary block of the chain called the "genesis" block. The time stamp gives each block an unchanging transient situation in the chain. A theoretical exchange epitomizes the way blockchain works. With regard to a deal, a vender consents to offer a gadget to a purchaser for one "coin." In a system of PCs, one node (purchaser) communicates code that will consequently deduct one coin from the purchaser's record and add it to the dealer's record when the merchant delivers a gadget to the purchaser. A smart agreement is conceived, i.e.,

called "Smart Contract." That is, the execution some portion of contact was decreased to code that is actualized by nodes and confirmed by a network of nodes before it is changelessly added to the database. When the gadget is delivered, the smart contract is executed. Different nodes get the exchange and go to confirm it by guaranteeing that the purchaser in certainty has the coin it has offered to the vender for the gadget. The confirmation may involve taking a look at the most recent exchange of the purchaser's record to ensure it holds adequate assets for the buy. The succession of the transaction is recorded in an immutable record, i.e., a blockchain, by constraining the nodes in the system to contend in taking care of a mathematical problem for the option to include the following block of exchanges to the chain, connecting the winner's new block to the past block, restarting the opposition to include the following block each time an answer is found, and dismissing any endeavor to embed or supplant block prior in the chain. In that capacity, the purchaser cannot spend the coin he has given to the merchant once more, as everybody in the framework knows the purchaser no longer has the asset.

2 Basic Structure of Blockchain

In blockchain cryptographically link exists between all blocks. Blockchain is a mutual, distributed ledger that encourages the procedure of recording exchanges and monitoring tangible assets (property, house, vehicle) as well as intangible assets (advanced cash, protected innovation rights) in a system. Fundamentally, it stores data and records its developments in a distributed domain. How about we investigate its subtleties.

It is an open and dispersed database that keeps subtleties of assets and its developments/exchanges over a peer-to-peer network. Every transaction will be made sure about through cryptography and later all the transaction history will be gathered, what is more, put away like a block of information. At that point, the blocks are connected along with cryptography and made sure about from interruption. The entire procedure will make an unforgeable, and unchanging record of the transactions that occurred over the system. Also, these blocks of records are duplicated to each taking part nodes in the system, so everybody will approach it. The incredible preferred position of blockchain is that it can store any sort of asset, its possession subtleties, history of the possession, and area of advantages in the system, regardless of whether it is the bitcoin (digital cryptocurrency) or some other assets like a digital certificate, individual data, an agreement, title of ownership for, even the real-world objects.

The amazing element of blockchain is that we can make a belief over non-trusting elements. No need to verify trust between nodes in the blockchain because each node has capacity to validate and approve the chain for themselves. The incongruity is that the common doubt among member is the thing which keeps the blockchain secured.

The information in the blockchain is put away as an individual block, that is the reason it is called blockchain. The blockchain is an assortment of blocks connected
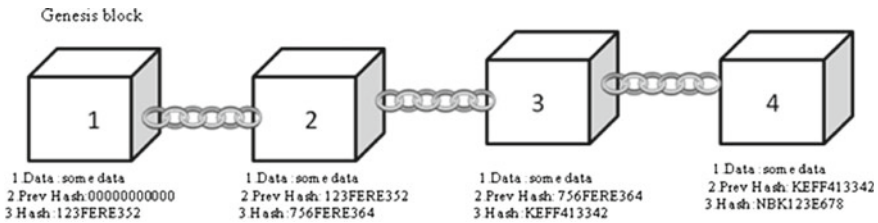
Fig. 11.2 Basic structure of blockchain

together as linked list. Each block in the blockchain will have the accompanying fields as shown in Fig. 11.2.

a. Data: Stores the information
b. Previous hash: Stores the hash of the past block
c. Hash: Hash an incentive for the current block which can be utilized to allude this block.

The most significant thing is the data field which contains genuine information (like transaction subtleties, resource details, and so on) that are put away in this field. The past hash will store the hash estimations of the past block (think about it as a connection to the past block), the blocks are associated through this value.

3 Process of Transaction Get into the Blockchain

We saw that blockchain has its own remarkable data stockpiling structure, the information appropriation in a blockchain has additionally a different methodology. They do not follow the broadly embraced client-server model rather the peer-to-peer model. The companion to peer information appropriation approach gives the explanation for the free nature of blockchain; there is a lack of central authority. As there is no central control over the blockchain, validation of blocks can be done by the validation process as shown in Fig. 11.3. In the era of digitalization, hacking and data breaching are the common problems all businesses are facing. The development of this technology has changed the way business transactions were done in the past. It has not only given birth to the digital currency but also transforming the businesses and societies [5].

3.1 Validation of Blocks

As we portrayed over, the asset and its transactions are put away as associated blocks in the blockchain. Only valid transactions are added to the blockchain. Actually saying, validation in blockchain is just the way toward finding the block hash. In a blockchain, only after validation all the blocks are added to the blockchain. At
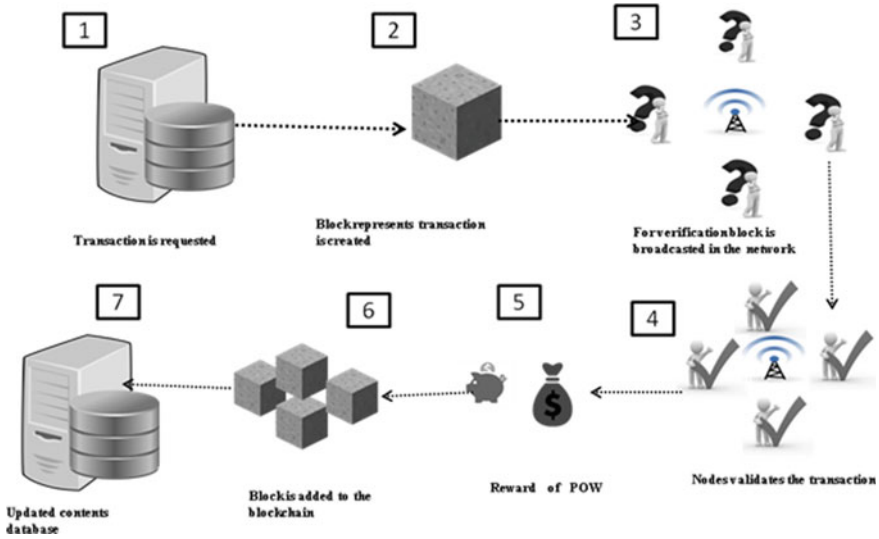
Fig. 11.3 Transaction validation process in blockchain

whatever point transaction takes place in the blockchain it will be added to a block; now and then one transaction for every block and in some cases a few transactions per block. It relies upon the block size and the idea of the arrangement. At the point when the transaction is added to the block, it must experience an approval process before it is being added to the blockchain as a valid block. The hash algorithm (like a 256) helps to evaluate hash value for the block.

The hash value has certain properties as well. The primary concern is that the hash worth ought to be sans crash for example no two blocks ought to have similar hash value. Since each block is spoken to utilizing the hash value it ought to be indistinguishable. The subsequent property is that the hash value ought to be irreversible. This implies the block data could not be retrievable from the hash value.

3.2 Proof of Work

It requires the individuals who own the PCs in the system to take care of a complex mathematical problem to have the option to add a block to the chain. The problem-solving method is known as mining, and "minors" are normally compensated for their work in digital money.

In any case, mining is not simple. The mathematical problem must be tackled by experimentation and the chances of a solving problem are around 1 in 5.9 trillion. It requires significant processing power which utilizes extensive measures of vitality. This implies the compensations for undertaking the mining must exceed the expense

of the PCs and the power cost of running them, as one PC alone would take a long time to discover an answer for the mathematical issue.

3.3 Proof of Stake

Later blockchain systems have embraced "proof of stake" approval consensus mechanism, where members must have a stake in the blockchain—as a rule by possessing a portion of the cryptocurrency to be in with an opportunity of choosing, checking, and approving transactions. As there is no need for mining, it recovers more processing power resources.

What is more, blockchain advancements have developed to incorporate "smart contracts" which consequently execute exchanges when certain conditions have been met [6].

3.4 Smart Contract

Smart contract is a set of rules in a blockchain and executed when conditions are matched. At the most fundamental level, they are programs that run as they have been set up to run by the individuals who created them. The advantages of smart contract are generally obvious in business collaborations, in which they are regularly used to authorize some kind of understanding so all members can be sure of the result without a third-party involvement [7].

The simplest approach to clarify what a smart contract does is through a model. On the off chance that you have at any point purchased a vehicle at a business, you know there are a few stages and it tends to be a baffling procedure. On the off chance that cannot pay for the vehicle out and out, you will need to get financing. This will require a credit look at and you will need to fill many forms with your own data for verification of identity. En route, you will need to communicate with different employees, including the sales person, fund dealer, and loan specialist. To repay their work, different bonuses and charges are added to the base cost of the vehicle.

What smart contract on a blockchain can do is smooth out this complicated procedure that includes a few mediators on account of an absence of trust among members in the exchange. With your personality put away on a blockchain, loan specialists can rapidly settle on a choice about credit. At that point, a smart agreement would be made between your bank, the seller, and the moneylender so that once the assets have been discharged to the vendor, the loan specialist will hold the vehicle's title and reimbursement will be started dependent on the concurred terms. The exchange of proprietorship would be programmed as the transaction gets recorded to a blockchain, which is shared among the members and can be checked whenever.

4 Types of Blockchain

There are four different types of blockchain as shown in Fig. 11.4.

4.1 Public Blockchain

How about we investigate the various sorts of chains. Also, start with block blockchains, which are open source. They permit anybody to take an interest as clients, excavators, engineers, or network individuals. All transactions that occur on public blockchains are completely straightforward, implying that anybody can know details of transactions.

Public blockchains are intended to be completely decentralized, with nobody individual or element controlling which transactions are recorded in the blockchain or the request wherein they are prepared [8].

Public blockchains can be profoundly oversight safe, since anybody is available to join the system, paying little mind to the area, nationality, and so on. This makes it very difficult for authorities to close them down.

In conclusion, open blockchains all have a token related to them that is commonly intended to boost and prize members in the system.

Examples of public blockchain are Bitcoin, Ethereum, Litecoin.

4.2 Private Blockchain

Private blockchains are also called as permission blockchains and have various eminent contrasts from open blockchains. Members need to agree to join the systems.

All transactions are accessible to environment members that have been allowed to join the system. Private blockchains are more unified than open blockchains.
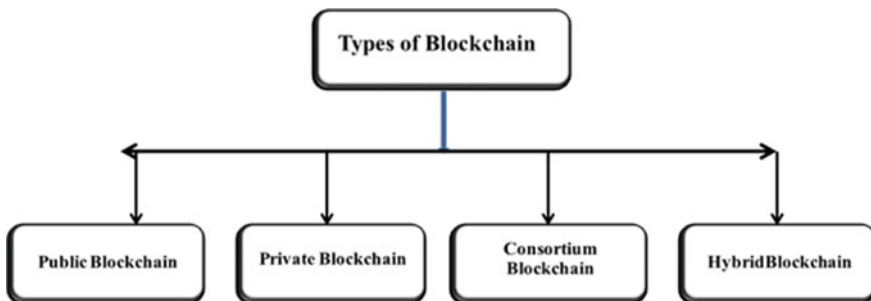

Fig. 11.4 Types of blockchain

Private blockchains are significant for undertakings who need to work together and share information, yet do not need their delicate business information obvious on a public blockchain. These chains, by their temperament, are progressively brought together; the entities running the chain have huge command over members and administration structures. Private blockchains could possibly have a token engaged with the chain.

Examples of private blockchain are Multichain and Hyperledger projects (Fabric, Sawtooth), Corda, etc.

4.3 Consortium Blockchain

Consortium blockchain is similar to private blockchain except private blockchain is managed by a single person and consortium blockchain is managed by group of people. Here, group of people can act as a node and deliver data or perform mining. Consortium blockchains are widely used by banks, government organizations, etc.

Examples of consortium blockchain are Energy Web Foundation, R3, etc.

4.4 Hybrid Blockchain

This signifies it strengthens the protection advantages of a permissioned and private blockchain with the security and transparency advantages of a public blockchain. That gives organizations critical adaptability to promote what information they need to make publicly open and what information they need to keep hidden. Hybrid blockchain permits us to handily correlate with other blockchain protocols, taking into account a multichain system of blockchains permission [9].

This usefulness makes it straightforward for organizations to work with the transparency they are searching for, without giving up security and protection.

Likewise, having the option to post to different public blockchains without a moment's delay builds the security of exchanges, as they profit by the joined hashpower being applied to the open chains.

Example of a hybrid blockchain is Dragonchain.

5 Blockchain Role in Social Impact Initiatives

5.1 Fraud and Risk Reduction

Probably the greatest favorable position of blockchain for social effect is the decrease of fakes and dangers related with the project itself. A tremendous issue is corruption,

particularly at the administration level. This implies voracious individuals utilize the cash expected to give help to the penniless. This is made conceivable as a result of the traditional methods that are not straightforward enough to tackle corruption.

The most ideal approach to take care of every one of these issues is by utilizing blockchain. Blockchain offers a total sealed arrangement where every transaction is confirmed utilizing consensus techniques. There is no reliance on an incorporated position and henceforth is liberated from any sort of extortion. The data put away in the blockchain is additionally permanent, which implies that once put away, it cannot be altered or changed by a malicious user.

5.2 Reduced Administrative Costs

Charities require a ton of work to oversee appropriately. That implies going through a great deal of cash should be spent on authoritative expenses. With blockchain, these authoritative expenses can be decreased. With smart agreements, it is presently conceivable to oversee budgetary and legitimate middle people. Automation is consistently useful and consequently makes it simple for everything to manage viewpoints that are dull or non-innovative.

5.3 Accountability and Transparency

By utilizing blockchain, it is presently feasible for good cause to be responsible and straightforward. People are consistently doubtful of noble cause. In any case, with blockchain, contributors can make certain of what they are doing. They can perceive how their commitments are having any kind of effect.

5.4 Faster Border Transfers

Regular banking channels are not giving much performance with regard to moving cash globally. It can take anyplace between days to send cash. On head of that, there is likewise an expense related with the exchange. As most causes are worldwide, they are in consistent need to do global exchanges. The late reach can hamper their endeavors.

Without involving central authority, digital cash can be transferred over the network. With it, they do not need to pay the middle people and furthermore do not need to stand by excessively long for the exchanges to get finished.

5.5 Improved Accessibility

With blockchain, it will presently be workable for anybody to move or get value. They do not need to rely upon banking to have the option to do these. This is a blast for noble cause and NGOs that are attempting to help individuals from all foundations. By making this methodology, the foundations likewise do not need to do twofold exchange and decrease both settlement and cost times.

5.6 Social Sectors That Are Impacted Using Blockchain

In this section, we are going to go through the different sectors that are being impacted by blockchain from a social point of view. The statistics shared in the section are taken from the standard blockchain for social impact study.

5.7 Agriculture

Horticulture is one of those areas that require cautious consideration. It can affect a colossal populace over the world. The fundamental centre is to improve three key parts of the gracefully chain in agriculture. This incorporates improving straightforwardness, delectability, and effectiveness. It will ensure farmers are all around associated with the consumers.

A portion of the key features that are partaken in the investigation incorporates the accompanying

- New activities are under two years of age;
- None of the new activities have in excess of 1000 recipients;
- Some of the activities can arrive at a million recipients;
- Most of the applications are for-benefit.

With blockchain, these issues can be settled. Above all else, it can decrease pollution and fraud in food. This can occur with the assistance of blockchain proficiency and straightforwardness. Blockchain's job is to improve the outsider contribution by guaranteeing that they are following, gathering, and overseeing information in the most ideal manner. With blockchain farmers and wholesalers will get their installments quicker than any time in recent memory improving their capacity to take a shot at their next arrangement of activities quicker.

Projects: AgriDigital, Grassroots Cooperative, Bext360

5.8 Democracy and Governance

The following division where blockchain can assume a critical job is democracy and governance. At the present time, governments are open to blockchain and its job in improving majority rules system and administration.

Key features

- Governments began blockchain as right on time as 2008;
- 21 activities across democracy and governance;
- 81% of the activities have seen accomplishment by mid 2019.

Less than half of the activities are for-benefit.

Governments run on trust. Also, that is the place blockchain becomes an integral factor. With blockchain, governments can address security identified with the location information trade. What is more, it will likewise permit clients to cast a ballot by means of blockchain, which makes them in a flash countable and discernible.

By utilizing blockchain, the legislature can likewise store residents' information in a vastly improved manner. The information is unchanging, which implies that there is no resident information that can be wrongfully erased or altered. It additionally enables organizations to get to the information at whatever point they need. The absence of centralization additionally implies that there is no main issue of disappointment. The legislature can likewise run legitimate crowdfunding utilizing blockchain.

Projects: e-Estonia, Votem.

5.9 Health Care

Healthcare division is one of those parts that have huge amounts of activities by both for-benefit and non-benefit associations. With blockchain, human services can improve computerized social insurance records. It likewise improves pharmaceutical gracefully chain the executives. Obviously, blockchain offers a decentralized, productive, and secure arrangement.

The key advantages incorporate appropriate electronic well-being records, better protection usage, and fake medications.

Undertakings: Modium.io.

5.10 Philanthropy and Aid

Social effect can be best observed from the altruism and help division. At the present time, the guide and altruism do not arrive at their proposed use. This is a direct result of the immense wasteful aspects that the current stage endures with regard to help

and generosity. Indeed, even with such a great amount of speculation, there is as yet a requirement for extra assets to satisfy the need for fundamental human rights, destitution, and access to training.

Key features

- More than 80% of the activities are non-benefit;
- Over 55% of the activities are arriving at fewer than 1000 individuals.

Billions of dollars are put resources into helping the poor. Be that as it may, these guides are for the most part abused because of an absence of straightforwardness. Truth be told, the greater part of the guide never contacts the planned individuals. This has additionally driven individuals to not add to these non-benefit associations. Blockchain can take care of these issues and help hoist the trust in non-benefit in using the assets.

Projects: Ixo Foundation, Disberse, RootProject.

5.11 *Insurance Segment*

In the insurance segment, consider the head as the insurance agency. The objective of the insurance segment is to decrease his danger of payout and to gain the best yields based on the accessible items. At that point we have an agent whose objective is to gain the commission on sale of product.

At last, we have a client, whose objective is to lessen his monetary risk at the event of an occasion (e.g., sudden death, or, accident, or then again, flight delay). Each of the three members in the commercial center has totally various incentives and various arrangements of data. For instance, the insurance agency could model the specific hazard an item faces and could adjust costs as needs be. The specialist could just concentrate on selling the item with the most noteworthy insurance. Next, the customer would need to pick a protection item that would give the most noteworthy hazard confirmation in any event cost. The motivations of every one of the three players contrast essentially and differ as indicated by availability of data at the time of transaction.

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