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Use of Blockchain Technologies in Smart Cities

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Abstract: ***A city is called a smart city where every citizen gets quality government services using the technologies like Information and Communication Technology (ICT). ICT also helps in providing operational efficiency in information sharing with the public. Smart cities promote better quality of life by using modern technologies and economic growth. Blockchain helps in end-to-end data transfer with great efficiency, transparency and security. Every data is stored in a block which has a hash value also considered as digital signature. In this paper, it is discussed how we can use Blockchain technologies to promote smart cities and provide better services. Also, it discusses various challenges and trends in use of blockchain technology in building smart cities.***

Keywords: ICT, smart city, hash value, digital signature, Blockchain technology, economic growth, Ethereum, decentralized.

I. INTRODUCTION

Smart cities are the cities where future of digital technologies resides . To build the smart cities, there is a need of great planning, discussions and economic planning as well. Countries where most population falls in low- and minimum-income categories knows that it is going to be much more difficult task to manage urban growth. Most countries in near future will come across many difficulties in providing basic services to the growing population. Services like housing, education, healthcare, transportation and many more basic services will be difficult to provide in existing system. Smart cities not only provide a sustainable growth of citizens but also it helps government to manage various tasks efficiently. The introduction of Blockchain Technology provides various improvements for application of smart cities. Blockchain Technology can help in building smart city infrastructures, make changes in ecosystems for better consumer services, and provide innovative applications. Blockchain is considered as a boon for growth and prosperity in the process of building smart cities as it provides efficient solutions, secures the sensitive data transfer and provides cross-platform solutions to various smart city applications.

Blockchain technology was first introduced in a publication by Haber and Stornetta in 1991. To know some concepts of Blockchain, below are some terms which can help for better understanding:

1) *Nodes:* Nodes are the computers on the blockchain network. Collection of nodes makes a network through which they interact.
2) *Transactions:* Each part in a Blockchain is a transaction. If you want to change anything on blockchain, it creates a new transaction. If we transfer any money from one account to another, it also represents as a transaction. Every transaction on blockchain is digitally signed. Each transaction to get approved it requires 50%+1 approvals from accounts in network.
3) *Block:* Blockchain holds data in a block. Every block is linked to other block using cryptographic hash. All blocks are stored in each node. Data from several transactions are stored in Blockchain's block.
4) *Account:* Accounts are made up of two keys, a private and public key. Private key holder is the owner of the blockchain account. There is no way to retrieve account if we forget our private key or it is lost.

Blockchain features are:

- *Decentralized:* The number of nodes in network represents the number of places data is being stored.
- *Scalable:* There is no limit on number of nodes in the network.
- *Safe / Secure:* Blockchain is almost impossible to tamper or break. As mentioned, it requires more than half of nodes approval in the network to get transaction carried out, it becomes more secure. If a hacker or attacker tries to tamper any piece of data, a new block is created, which also needs to get verified by other devices within the Blockchain network. The cryptographic hash of the node is checked and node is ignored until it returns to an original value if any node in the network responds differently from the others.
- *Intelligent:* It provides feature to write custom code for different applications, thus provides room for different use cases.
- *Auditable:* Blockchain provides chronological tracking of all changes which means each block is linked to the previous block through a hash. Through a block we can reach to the starting block of Blockchain, i.e. "Genesis Block".

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II. LITERATURE REVIEW

Blockchain technology provides a system which provides security in storing information because it is difficult or impossible to penetrate into any system illegally. Smart cities can make use of this technology in many ways, the biggest advantage will be transparency.

All processes will be able to carried out with consensus and transparency. Also, it will help to move digitally in almost every field. To implement Blockchain technology, we need to learn the basic terminologies for it. Carmen, Alexandru, Alin and Dragoș tried to explained the basic terminologies in their research paper published in 2019. They explained all basic terminologies of Blockchain while explaining architecture of smart city.

Mahendra in his research paper explained about challenges in implementation of the Blockchain in urban areas. Dipak Gade and P Aithale showed some of the fields which are going to be benefitted by implementation of Blockchain. This paper will try to explain how world is trying to implement this technology and where does India stand in implementation of it.

III. RESEARCH GAP

There are many research studies done on how Blockchain is going to change the implementation of smart cities. But, as there is no proper definition for smart city, every region or country has different expectations and limitations while building the smart cities, therefore various countries are following different architecture in building the smart cities. This paper is going to help in understanding different countries plan and also helps in understanding the India's planning and policies for smart cities. It also describes the challenges and applications of Blockchain technology in smart cities.

A. Blockchain Technology for Smart Cities

As discussed above, various characteristics of blockchain technology can help in building smart cities. Blockchain technology makes data transfer, data storage, data retrieval in easy and secure manner.

As every data is stored in a block with hash value associated with it, there cannot be any mischievous activity with data or there cannot be any data tamper.

As it has decentralized network, everyone has a copy of data, so it provides transparency among network. Blockchain can help in many fields including cryptocurrency, smart contracts and management of system where many actors are involved. One of the most useful features of Blockchain technology is that it can help in providing transparency in institutions irrespective of local or regional, by providing them the facility of secured communication platform for sensitive data and thus also provides confidentiality. These features also help citizens to take part in decision making processes like local or general elections at their comfort and easily. This can also help in increasing citizens participation in democracy.

As every data is stored on decentralized network that means every authorize user has permission to view the data, it provides confidentiality but also there is a chance of data breach or tampering of data can be done by any unauthorized user illegally. As every block has hashes associated to it so network hacking is probably not possible but there are chances of it. So, data security must also be regulated on time-to-time basis.

With the use of cryptography technology, every transaction or data alter in the network is recorded with hash value. So, it is unlikely that data can be altered easily by any outsider from the network. Also, if there is consensus then, any transaction will need to e approved by each node (each participant in the network).

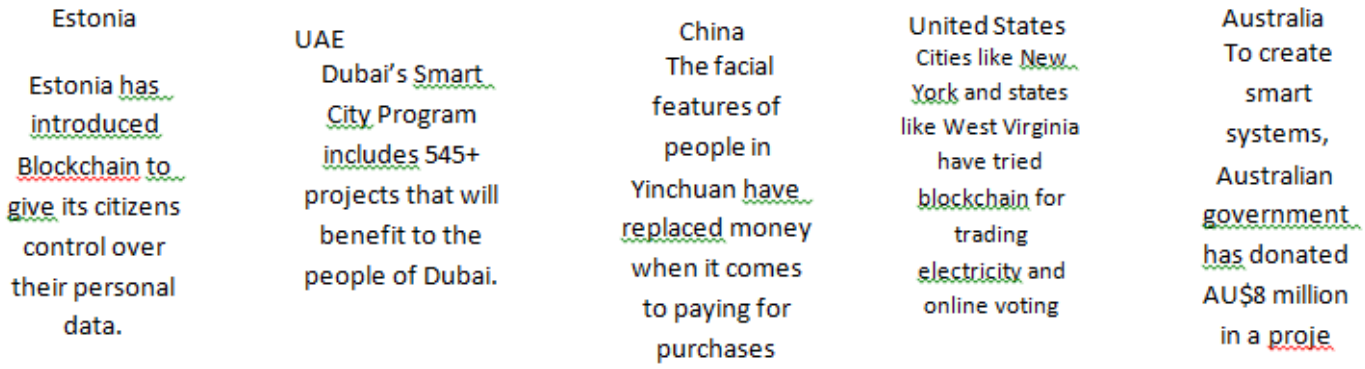
Blockchain provides efficient way to manage large systems where tons of data or many actors participate at a same time. A big example of such system is any central government authorized or state board universities result declaration process. Whenever such universities declare their results on their official sites, there are news of websites getting crash because of large traffic on it at a same time. Such systems can be build using blockchain and provide efficient way.

Blockchain helps government authorities and officials to track down each resource through its source as well as destination. It helps in monitoring of resources and helps to find any fault in system if any failure occurs. Distributed ledgers are one of the great features of blockchain, it acts as central ledger and thus provides transparency in management. Also, any changes or modification can be performed easily through authorized entities.

B. Existing Plans

The below flow chart shows how different cities of different countries using Blockchain projects: Countries and cities with Blockchain Projects

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According to one of the articles of iberdrola.com, Dubai will be the first city in integrating all its services in Blockchain. Apart from this, there are also some other UAE government's plans for promoting Blockchain with a vision to become fully digitized government.

China is helping various companies and individuals for easy deploy of Blockchain based application faster and cheaper through its Blockchain based Service Network (BSN) initiative.

European Blockchain Partnership (EBP) is an initiative to promote Blockchain technologies to develop a secured and trusted European Blockchain Services Infrastructure (EBSI). It is to provide world class services with privacy, security and efficiency.

The Brazilian authorities are planning to use Ethereum platform for creating applications including online voting system and for public bidding on contracts with government's online bid solution.

Indian government is also focusing on implementation of Blockchain based technologies in various domains such as NITI Aayog in association with Gujarat Narmada Valley Fertilizers & Chemicals Limited (G N F C) has introduced a system for fertilizer subsidy which is made on Blockchain Technology. Future Skills Prime Program is an initiative by Indian Government for building, creating awareness and talent management, to provide skills or upskilling of individuals in the field of BCT.

IV. CHALLENGES WITH BLOCKCHAIN TECHNOLOGY

A. Platform Adoption

There are various Blockchain platforms available in the world today. But each platform comes with their pros and cons with them. The most important part here is to understand which platform can provide us better outcomes with better pricing, stability and most important security. Sometimes adoption of a high- end platform may of no use in our small application, and thus it may cost us with higher costs.

B. Regulatory Compliance

While implementing the Blockchain for any application, thorough knowledge of regulatory compliance must be there. According to the requirements, regulatory policies can be evolved.

C. Identification of Suitable Cases

As every application has different requirements of security level, storage and privacy level, therefore blockchain suitability must be known well before.

D. Awareness and Skill Set

For successful implementation of Blockchain technology depends on how it is implemented, and to understand it skilled manpower is required. There must be availability of skilled manpower who understands Blockchain capabilities are very important to fully utilize its benefits.

E. High Energy Consumption

Mining requires computers to solve complex problems. Currently, miners consume 0.2% of total electricity produced in world. This may increase once the use of Blockchain increases.

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V. GOVERNMENT STRATEGIES

A. National Blockchain Framework (NBF)

NBF will be developed in such a way that will help utilize Blockchain features in various domains like education, finance, health, etc. For this, a national level infrastructure is required, so that each citizen can get benefit of each service.

B. Geographically Distributed Nodes

National level infrastructure will be achieved using technique which can host NBF at different nodes across the country. For interested individuals or entities there will be security audit and thorough assessment by authorized agencies before being part of it. Apart from this, technical parameters can also be evaluated.

C. Blockchain-as-a Service

Different sectors can use NBF for deployment or hosting of large-scale applications. Sectors like education, healthcare, agriculture supply chain and many more will be benefitted using this service.

D. Collaborative Efforts

To achieve these many milestones requires collaborative efforts involving partners from academic and research institutions, industry experts and Government.

E. R&D for Blockchain Challenges

Solutions for challenges can only be derived if research is promoted in the field. Also, various research projects will help to understand various aspects for large-scale implementation of Blockchain Technology.

F. Awareness Creation

Government is in planning to host various user awareness workshops to create awareness of Blockchain technologies and its applications. This will boost the adoption of Blockchain technology in various fields.

G. Policies and Regulations

Meity and other Government ministries will plan stakeholders' meetings to work on regulations and create policies as per requirements. Policies can be updated as experience will be gained in implementation of various applications.

VI. CHALLENGES INDIA FACES AND HOW BLOCKCHAIN HELPS TO OVERCOME THEM

Integration of various models with Blockchain helps in improving accuracy, security, transparency and efficiency of the system. Use of Blockchain benefits many fields like supply chain, increasing efficiency in existing systems, promoting transparency, etc.

A. Agriculture

Agriculture is an important part of India's economy. But, due to various reasons the condition of farmers is not that good. Using Blockchain, we can enhance the system which helps in accurate traceability, that is from seed production to delivery of crops. This helps in making process centralized and helps to cut the middleman costs.

B. Smart Healthcare

A platform where we can store each and every patient medical data, so that whenever necessary patient can easily share the past medical information to doctors or doctors can easily understand the current medical situation of the patient by past records. As this platform have sensitive information of patient medical records, its security and privacy must be maintained, which can easily achieve by Blockchain.

C. e-Voting

Voting is one of the ways where citizens can use their electoral power to choose their leader. But many a times, during voting day, many citizens miss their chance to cast their vote due to various reasons. But, if this whole voting process is done in a manner which provides transparency, confidentiality and at ease of each citizen, then it can promote citizen engagement in democracy. Blockchain features like decentralized, anonymous, transparent and secure can help in achieving e-Voting models for elections.

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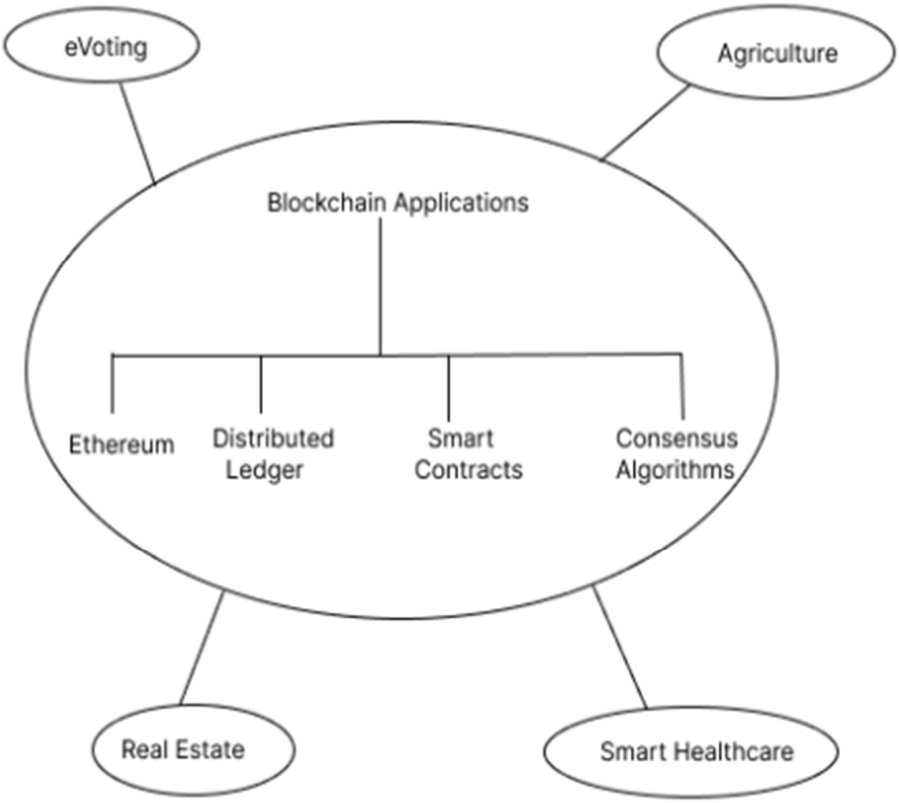
D. Supply Chain

The traditional supply chain system is centralized and has many loop holes for corruption, mishandling and tampering of product. With Blockchain's distributed ledger technology, we can enhance the system with accurate tracking and transparency. Food industry will be much more benefitted than any other industry, if blockchain integrates with supply chain modules. It will also help in cost reduction, less paperwork, reliability and traceability.

E. Real Estate

Real estate frauds are quite common in India. Blockchain provides secure and fast transactions through smart contracts between related parties. These contracts are made in such a way that they are easily verify the transaction and provide details. Features like transparent, secure and support various other functionalities related to ownership or mortgage registration, promotes the usage of Blockchain in this field.

VII. DIAGRAM



VIII. DISCUSSION

Implementation of Blockchain in various sectors is beneficial but for that we need large number of individuals with correct skills and ability to adopt new changes whenever necessary. Blockchain does have many advantages but while implementing there are some difficulties which need to be discussed before implementation. Every region has different geographical characteristics, regional characteristics, population factor, etc. Therefore, while building smart cities these conditions must be discussed before the implementation of the plan. Many countries have implemented Blockchain in various fields, and got positive outcome from it. India also has made some policies which will promote Blockchain and its features. Blockchain is a must in near future, it will be helpful in developing cities which are going to be smart, sustainable and futuristic. Smart cities which in turn will help in improving the overall architecture of the country.

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IX. CONCLUSION

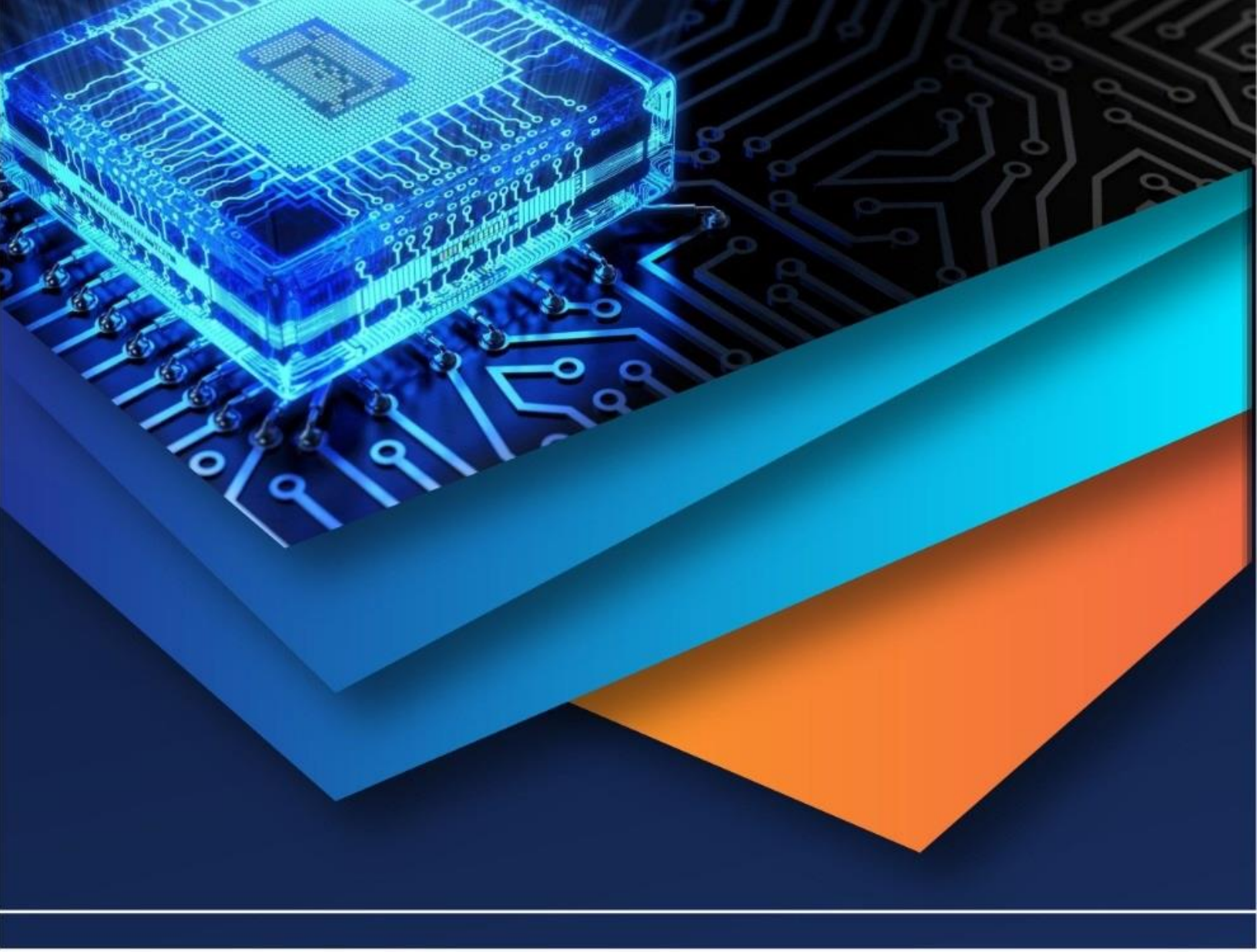
Every new technology is hard to get adopted easily in the initial phases. Blockchain is kind of new technology which can be the next step in data accessibility or privacy. It will not only help in data security, but also it will help in building an infrastructure which can be modern, citizen-first, and efficient. Blockchain is going to be important part in building smart cities, there will be many fields where blockchain is going to play crucial role. Many countries are trying to adopt Blockchain, and have started implementing policies for it. There is no proper definition for smart city, for some it is sustainable city and for some it is a city where all modern technologies and equipment are available. Therefore, many countries are developing the future cities according to their need, availability and with their definition of smart city. Also, apart from this, there are various cultural, regional and traditional characteristics while building a city. Hence, defining a smart city is not possible. But if anyone would like to explain the term in easy way that can be "a city where there is use of sustainable resources in sustainable manner for sustainable growth".

India has also started development in various sectors with the use of Blockchain. India is trying to promote Blockchain so that more people can get related skills for it and help in building Blockchain based platforms for smart cities. India may face major challenges in implementing smart city projects where there is more of cultural and traditional influence. But like digital payments, all will surely adapt to the changes, if implemented properly.

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