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A Survey of Blockchain Applications beyond Cryptocurrency

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Abstract: Blockchain since its inception in 2008 is being gaining a wide publicity. It is in early phase and its adoption is a general concern. There is a need of more interdisciplinary research to understand the barriers, enablers and diffusion of this technology. This paper reviews on the key applications of blockchain technology along with its benefits. Smart Vehicle Management, Agriculture, Healthcare, Cryptocurrency and Waste Management are the potential Areas for research in this technology. The research would be further carried out to build a prototype model for waste management using this technology.
Keywords: Blockchain, Cryptocurrency, Proof of Work, Hash, Distributed Ledger.

I. INTRODUCTION

Blockchain is a technology with high potential. It has gain extreme consideration after its introduction by Satoshi Nakamoto[1]. Technology is moving from centralized approach to decentralization. Block chain technology is used for decentralization. However huge amount of computing resources will be required to implement decentralization. This paper reviews and explores the blockchain technology, its benefits, Limitations and related application emerged in the literature.[2]–[5].

II. BENEFITS AND LIMITATIONS

Blockchain As a digital payment framework,has several advantages over existing electronic frameworks.

A. Benefits

1) *Transparency:* All blockchain network exchanges are cleared in the blockchain, which means a total, verifiable and unchanging record of any action exists.
2) Low or no Exchange Costs: The organization of the blockchain network is sponsored by the procedure of creation of the treasury. Exchanges on the blockchain network can be sent for a small or no exchange fee. Also, there is no cost to get to the blockchain network.
3) *Transactions Almost Instantaneous:* In traditional payment systems, compensation takes much longer.
4) *Exchanges of Blockchain Networks Immediately Register. Affirmation and compensation for these exchanges can occur in minutes to more than 60 minutes. Network security:* The blockchain network[5][24]itself is exceptionally secure thanks to the use of cryptographic and decentralized blockchain conventions. Individuals in general of the private key sets used to provide adequate security against the danger of a wild constraint hack or the inadvertent appearance of two clients producing a similar private key. Moreover, there is no single goal, combined with disappointment, which limits the vulnerability of the blockchain network to downtime and piracy.
5) *Financial Data Assurance:* Blockchain transactions can be performed without revealing to the beneficiary sensitive individual and financial data, limiting the potential presentation of such data to database piracy.
6) *Financial Access:* Despite the fact that it cannot give most of the administrations of account management and its specialized multifaceted nature may be too high for some clients; blockchain can offer incentive storage and payment services for clients who need access traditional financial services.
7) *No Risk of Fraud:* When sent and deleted, a blockchain exchange cannot be cancelled by the sender.[6]

B. Limitations

Few key limitations of blockchain are identified such as Throughput, Latency, Size and bandwidth, Security, Wasted resources, Usability, Corporate Shareholder Voting, Reducing Counterparty Risk, Cross-Border Payments[7].

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III. LITERATURE REVIEW

This sections presents the study of existing literature with respect to different applications of blockchain.

A. Cryptocurrency

One of application of blockchain 'Bitcoin' has also gained much attention as it has removed the third party Interference. The authors Giang Truong and K. Kyungbaek in their paper [2] discuss many alternates of the Consensus Algorithm inside Blockchain. The centralization system where everything depends upon the third party needs a trust which is doubted nowadays. The solution to this problem is that numerous independent organizations verify transactions, which changes the approach from centralization to decentralization. Since 2009 many variants of Bitcoin have been introduced like Ethereum, Nxtcoin. These public blockhain variants allow anyone to join and maintain the ledger and withdraw anytime. Because of this joining freedom it is difficult to implement the idea of applying human real-life consensus as it is composed from all the nodes before making a final decision. Due the surplus number of nodes the communication to exchange agreements between nodes is very complicated. Risk is involved while taking agreement from all the node which may harm the ledger holding procedure. Also, in order to append a block to the chain all the nodes need to show that there are more qualified than others to do the work. Hence a consensus algorithm is called as "Proof-Based Consensus". The nodes receive award for appending a block to the chain which encourages node to maintain the ledger.

The first variant of proof-based consensus algorithm is Proof of Work (PoW). In this nodes are only permitted to broadcast their blocks when they have performed effort by their computing power. Many algorithms exist like proof of elapsed time, proof of luck and proof of space. Proof based consensus Algorithm is used in Public Block chain and Voting based Consensus algorithm is used in private and consortium Block chain. The author concluded that the newly developed consortium and private Block chain has much potential with vote-based besides the Public Block chain with Proof-Based Consensus Algorithms. In [8] the author proposed security enhanced energy-efficient consensus algorithm. As consensus algorithm hash to create a new block which results in energy waste. The new blocks are generated in a single operation thereby reducing energy waste. Consensus algorithms that are used in public block chain environments consume a large amount of computing power to perform reckless hash calculations, raising energy waste and performance problems. Such issues are inefficient for use in private block chain environments. Proof of Majority consensus algorithm is available in a controlled, private or closed block chain environment. The algorithm does not require reckless hash calculations, which can solve problems regarding energy waste and performance. With a controlled, trusted, closed environment, all miner nodes participate in maintaining a single block chain, thereby addressing potential security issues that could arise from the vulnerability of the block- generated nodes. The author intends to verify the performance of the Proof of Majority consensus algorithm by performing a variety of verification simulations viz. controlling the time of creating of large miner-node environments and creating abnormal blocks to verify efficiency and performance.[8]

The author Baliga et. al.[3] in their paper discussed that blockchain based system is a classical distributed system where all participants are geographically distributed and connected via different kinds of networks. The platform of Blockchain is classified into two main types: Permissionless and permissioned[9]. Bitcoin and Ethereum are permission less hence publically available for use. Any node is allowed to conduct transactions and take part in the consensus process to advance the blockchain.

Participation in Permissioned platform such has Hyperledger Fabric and Multichain is closed ended. The advancing of blockchain is restricted to fixed set of nodes run by consortium members. To ensure privacy of diverse application including Internet-of Things ecosystem, the Block chain technology is considered as one of the options. Research is carried out in multifarious applications in academia and industry. A cryptographic mystery, Proof-of-Work plays a vital role in maintaining digital ledger of transactions. It also uses a changeable Public Key to record the user's identity which provides extra layer of security.

+Establishing trust of the participating machines is one of the challenge in IoT ecosystem which has not been met extensively. Block chain acts as a catalyst by enabling enhanced scalability, security, reliability and privacy. The hashing techniques used for encryption of the block data provides a better security. However this demands more processing power which is current lacking in the IoT Devices. There is a need to overcome this limitation of processing power. [4]

The author in [5] explores and classifies the published works found in the existing literature block chain technology and its practical applications. Other than bitcoin and Etherum[10], few more cryptocurrencies such as Bitcoin, Litecoin, Peercoin, Primecoin, Ripple, Permacoin, Blackcoin, Auroracoin, Darkcoin and Name coin are discussed. In addition to cryptocurrency blockchain has a wide potential and can be adopted for identity management, healthcare, financial inclusion, asset ownership, transfer of precious commodities such as silver, gold and diamond. But these all depends upon the nations regulations.[11]

Cryptocurrency has its own currency. A new block is introduced in the process through mining. Each node uses blockchain to verify whether the coin is legitimate or if it is not spend. A large number of participants reach an agreement before the transactions

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records are added to the blockchain. Mining process is a resources intensive task. Each mined block is verified for valid proof of work and proof of stake. The authors developed solutions to overcome block chain size problem, especially for transportable entity operation. This solution is able to overcome problems in entities that can be transferred by briefing the block on the block chain then compressing the summary block, so it make node easier to verify the payment because the block size is smaller and the number of blocks must be downloaded less. The test were carried out on a standard PC with Specifications: Intel (R) Core (TM) i5-5200U CPU @ 2.20GHz (4 CPUs), NVIDIA Geoforce 840M, 256GB SSD memory, 8GB RAM. The operating system (OS) is Windows 10 Pro 64 bit, with the python compiler version 2.7. The solution proposed by the author reduced the problems related to blockchain scalability, especially in block sizes. The solution of summarizing and compressing blocks can make nodes easier to verify payments because compressed summary blocks can have a lighter data size. Computing activities were made lighter for nodes with low processing power and memory. The author stressed the need of standardization for block summarization and block compression which is able to maximize the value of space saving.[12]

The internal details of blockchain are studied by the Java Application ChainTutor.[13] The authors Kazuyuki Shudo et. el in their paper discussed the fundamental problem Incentive mismatch in public blockchain. The incentive for nodes to support a block chain is economic, i.e., gaining coins, and is different from the incentives for block chain applications. An application cannot continue working if it's underlying block chain collapses due to the economic motivation disappearing. It is non-trivial to align the block chain node and application incentives, and this is still an open problem. Making applications portable is one potential solution to protecting them against collapsing along with their underlying block chains. Portability is also desirable for applications on private block chains. Minimizing the dependence of applications on their underlying middleware is a well-known best practice. It is difficult to update the data format or program code while retaining existing data on a middleware platform. The author proposed the study of program code and data for smart contracts. [14]

The authors in [10] proposed a heterogeneous multi-chains architecture, a main chain with parallel sub-chains for large-scale business applications The multi-chains architecture has sub-chains transaction witness and it enables efficient cross chain transactions in high scalability and extensibility.

The authors in [15]focuses on two key costs that are affected by blockchain technology: the cost of verification, and the cost of networking. Users need to be able to efficiently verify and audit transaction attributes, including the credentials and reputation of the parties involved, the characteristics of the goods and services exchanged, future events that have implications for contractual arrangements, etc.

B. Smart Vehicle Network

The author [6]proposed a Block-VN model, an architecture based on blockchain in the smart city for the vehicle network, which allows the development of the distributed network of large-scale vehicles in a more efficient and effective way.

C. Agriculture

The agriculture sector needs to increase more crops to produce sufficient food with minimum resources and enabling transparency across the supply chain. Farmers need to be paid fair income which is profitable. Blockchain along with Internet of Things can be used make farming a sustainable practice by optimizing farming resources including water, labour, and fertilizer using a simplified approach[16].

D. Health Care

The authors Zainab et.al [9] presented the use of blockchain in managing and sharing electronic health and medical records. The main focus is on the challenges that may expose patient's privacy and the resiliency of Blockchains to possible attacks. The security and privacy challenges, including the Sybil attack are discussed. Digital means and new digital business models[17] can be used to maintain electronic health records. Personal information, diagnostic reports, prescriptions can be the various attributes. Blockchain may have a considerable impact on a patient's record sharing, billing, and medical research[16]

E. Waste Management

With development of urban areas waste management has become a severe problem. Poor management of waste led to contamination of water, soil and atmosphere. Proper management of waste may lead to a cleaner environment. The authors G. Adams et. al in their paper highlighted the use of blockchain technology to process transactional waste management data. Blockchain has several advantages over traditional system.[18] Minimization of waste is one of the important goals for organizations and supply chain. Smart contracts can be used to ensure the minimization of waste. For a Smart contract execution agreements a Performance Criteria

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for waste reduction metrics can be included. There is a need of IoT devices like smart sensors which can be attached to transport devices. Also smart barcodes can be attached to the waste material.[19]

For waste management, identification of waste so as to make a by-product is most important. Eliminating waste completely from the supply chain[20] is not possible. This needs a permanent record and tracking of waste disposition[16]. Fraud and manipulation, wrong or loss of information, manual processing, technology illiteracy and lack of control are concerns of waste management in a blockchain environment.[21] The authors R. Mashelkar et. al [23]presented a case study of 'zero-garbage ward' model stressing the need of two major parameters of success Energy Environment. Further need of ASSURED transformational innovation is stressed. The attribute defined are Affordable, Scalable, Sustainable[22], Universal, Rapid, Excellent and Distinctive. There is a need for startups through promotional schemes for micro-waste management. The pilot project is executed at Pune in Collaboration with the Corporation and can be extended nationally.

IV. CONCLUSIONS

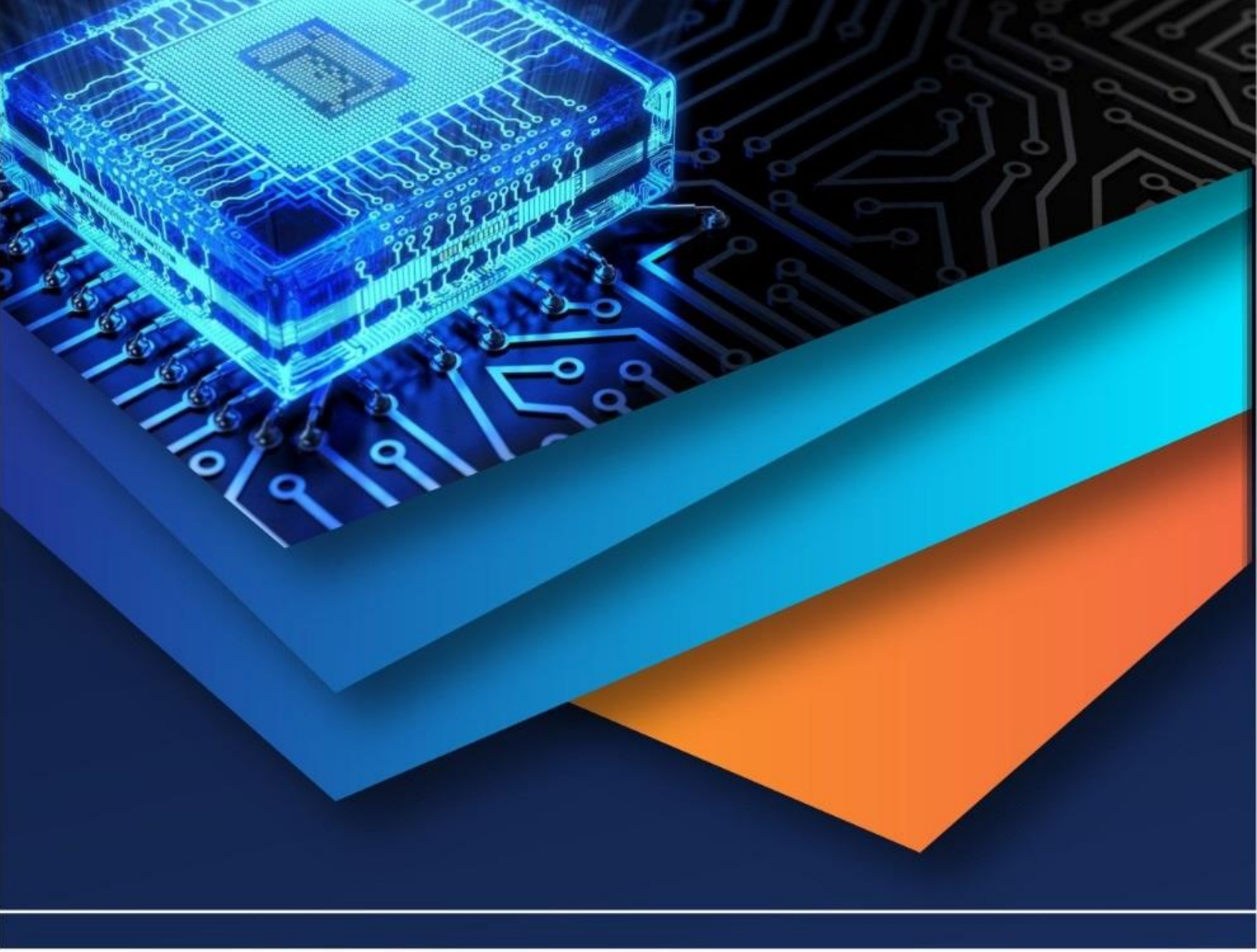
Blockchain and Cryptocurrency 'Bitcoin' are being used alternately as they were invented at the same time. The paper discusses the other key applications of Blockchain to cryptocurrency, Agriculture, Smart Cities and Waste Management. Further in-depth research would be carried out in Waste Management. Effective and systematic waste management is a severe challenge which is affecting many developing countries. Increase in Urbanization, population explosion and rapid developments are responsible for generation of excess amount of waste. The major problem lies in growth of waste generation rates, depletion of landfill space, waste disposal and management method. To improve the efficiency, it is necessary to introduce modern waste management system to keep track of full cycle of waste management from the collection methods to its reusability.

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