Applications of Blockchain Technology in Civil Engineering

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ABSTRACT
Blockchain technology, as a general-purpose technology, has the potential to transform the way people live and do business, as well as the overall development of an economy. It enables secure data collection and has the potential to alter the construction sector by enhancing transparency and efficiency. The research does a bibliometric analysis of the literature on monetary mediums and the emergence of bitcoin, the first digital medium to overcome the "double-spending" issue. Blockchain technology may improve the efficiency of money transactions, quality monitoring, and contractual procedures. With the advent of construction 5.0, the industry is shifting away from a technology-centric strategy to one that prioritizes people. Blockchain technology may benefit the construction sector by simplifying contract administration, boosting payment transparency, and expediting project management. Contract management, sustainability, supply chain logistics, and transparency are all promising areas for blockchain technology due to key qualities such as immutability. The report does, however, emphasise the limitations of implementing blockchain technology in the construction sector, highlighting the necessity of greater stakeholder education, more effective regulatory frameworks, and the creation of blockchain platforms geared to the construction industry as a whole.

Keywords: Blockchain, Distributed Ledger, Civil Engineering, Productivity, Information,Transparency.

1. INTRODUCTION

The US construction sector has been struggling recently due to transportation challenges, inflation, increasing interest rates, and supply chain disruptions [1]. The company must also cope with challenges such as not being transparent and honest, conducting operations smoothly, breaking apart, payment delays, and completing projects on schedule [2, 3,4,5,6]. All phases of a project, including planning, design, building, operations, and management, are employing more IT solutions, leading to a digital transformation in the architecture, engineering, and construction (AEC) industry. A McKinsey report [7] indicates that the construction industry ranks among the least digitalized sectors, with barely 1% of its total value added digitalized. Lack of technology is likely causing many of the company's problems. Approximately 90% of large projects wind up costing more than expected. [8,9]. Software that calculates pricing based on historical data has emerged as a potential solution to these challenges [10]. Building Information Modelling (BIM) has greatly improved the building industry by allowing individuals to analyse and simulate various situations, identify issues early on, and employ more precise scheduling [11]. Despite the fact that quality control software is better at organising processes and ensuring they follow the standards, and automated review procedures are more fair and accurate [12], difficulties persist. Dealing with contracts in the construction industry may be difficult due to concerns with speed, lack of transparency, and follow-through [13, 14]. Because of these challenges, stakeholders have not been completely engaged and collaborative throughout the construction process. These issues present an

opportunity for blockchain technology to revolutionize the management of construction projects from inception to completion [15, 16, 17].
In blockchain, "blocks" are the building blocks. Blockchain is a worldwide ledger technology that securely transmits data over a network [18]. Each block contributed to the blockchain [18, 19] increases its size. Blockchains are a sort of distributed ledger system [19]. The construction industry could potentially address long-standing issues by utilising blockchain technology, recently developed and used in cryptocurrencies. Blockchain technology has the potential to save money and improve efficiency since it is open, immutable, secure, and trackable [19].
Blockchain technology has a lot of potential in the construction industry. The construction industry can use it for various purposes such as managing the supply chain, project bids, contracts, certifications, and permits. The introduction of a trustworthy, decentralised record system like blockchain may cause significant disruptions in the construction sector. This will result in more accountability, speed, and clarity, which benefits everyone. Project management can enhance data security, collaboration, and long-term success by incorporating blockchain technology. Some of the factors that may prevent blockchain from being beneficial in the construction sector include the necessity for consistent data formats, partner involvement, and the need for education and training [19]. Some individuals express concerns about the broad application of blockchain, especially in large-scale construction projects [15, 19, 22, 23].
Construction, one of the world's largest sectors, is undergoing significant transformation as a result of emerging digital technologies such as artificial intelligence (AI), the Internet of Things (IoT), virtual reality (VR), geographic information systems (GIS), and building information modelling (BIM). These technologies may benefit project partners in a number of ways. They may increase efficiency, reduce waste during construction, improve data exchange, and enhance visualizations, to name a few. Blockchain technology has advanced significantly since Bitcoin's first successful application, which might signal a significant shift in the construction sector in the near future.People are interested in how blockchain technology might enhance information management systems in the building industry by addressing common issues and altering the sector's structure and practices. Seven areas of the built environment have identified blockchain as a potential solution: smart cities and the sharing economy, smart energy, smart homes, smart government, intelligent transportation, building information modelling and construction management, and business models and organisational structures.Blockchain technology has several applications in the world of architecture and engineering. Cheng et al. (2021) identified five areas for further research: supply chain management, information management, contract management, integration management, and stakeholder management. They also investigated blockchain technology and its potential to support a circular economy (CE) in the built environment. They developed and tested a blockchain model based on a fictional scenario.To summarise, blockchain technology has the potential to transform the construction sector by enabling more efficient and environmentally friendly business models.

2. Bibliometric Analysis

2.1 Year wise publication

A year-wise paper publication analysis involves tracking and evaluating the number and trends of research papers published over time. This analysis helps in identifying growth patterns, peaks, or declines in research activity within a specific field or across various disciplines. It can also highlight emerging areas of interest, shifts in research priorities, and the impact of significant scientific discoveries. By comparing publication trends year by year, researchers and institutions can assess productivity, collaboration networks, and the evolution of knowledge in a given domain.

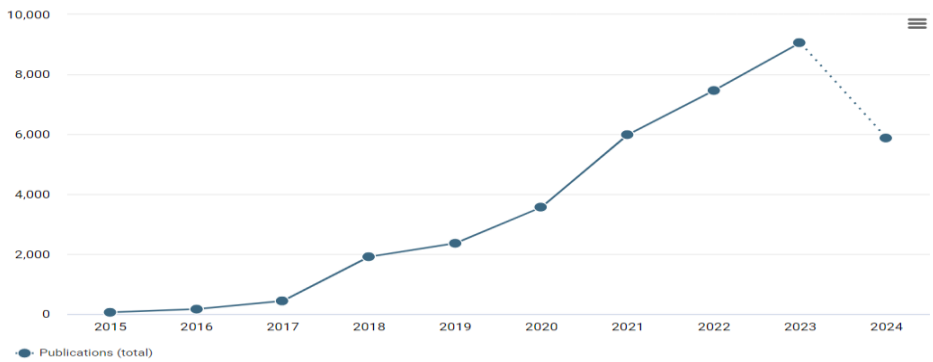

Fig 1. Year Wise Publication Analysis

2.2 Sources Analysis

VOSviewer is a powerful tool for analyzing and visualizing bibliometric networks, often used for source analysis in academic research. It helps in mapping relationships between various publications, authors, and sources by identifying co-authorships, citation patterns, and co-occurrence of keywords. In source analysis, VOSviewer can group sources into clusters based on shared characteristics like citations or thematic similarities, revealing influential journals or papers within a research domain. This enables researchers to uncover trends, key contributors, and knowledge gaps in a field. Its visualizations offer a clear representation of the interconnections and impact of different sources, facilitating deeper insights into academic landscapes.

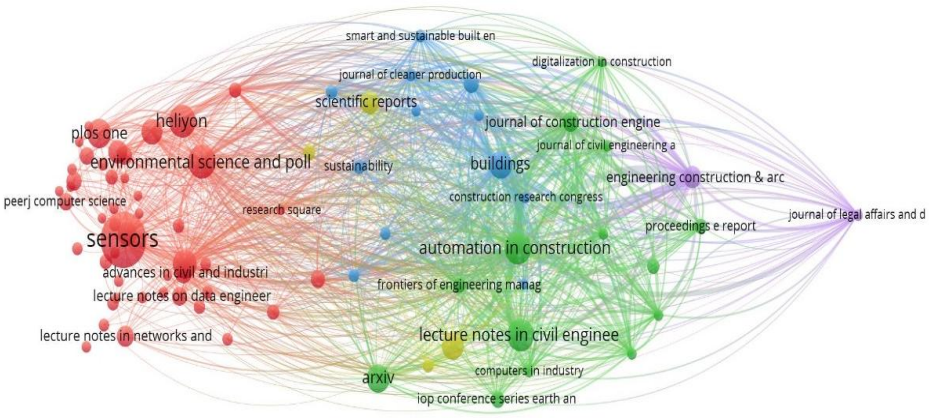

Fig 2. Sources Analysis

2.3 Author Analysis

In VOSviewer, author analysis focuses on identifying and visualizing relationships between researchers, highlighting collaboration networks, co-authorship patterns, and individual contributions within a specific field. By analyzing metrics like citations, co-authorship frequency, and clustering of authors based on research topics, VOSviewer reveals key influencers, prominent research groups, and the degree of collaboration between scholars. The tool's visual maps can show which authors frequently work together, who the leading contributors are, and how their work is interconnected. This helps in understanding the structure of academic networks, identifying potential collaborators, and recognizing trends in scholarly contributions across disciplines.

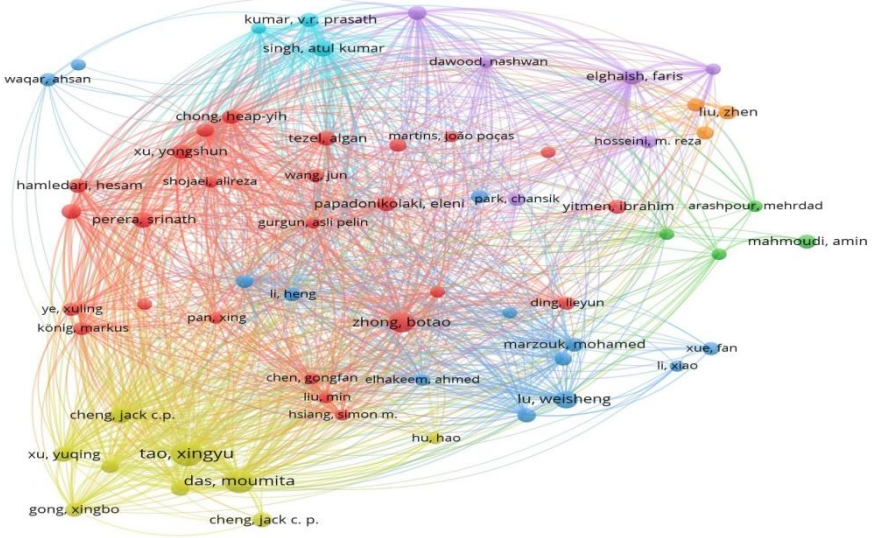

Fig 3. Author Analysis

2.4 Organization Analysis

VOSviewer's organization analysis examines the relationships and collaborations between institutions, offering insights into their impact and influence within a particular research field. It maps connections based on co-authored publications, citation networks, and collaborative projects, showing how different universities, research centers, and organizations interact. By clustering institutions with similar research outputs or collaborative tendencies, VOSviewer highlights key players, leading institutions, and emerging partnerships in the academic landscape. This analysis is valuable for identifying dominant research hubs, understanding the global distribution of expertise, and spotting opportunities for inter-organizational collaboration and knowledge exchange.

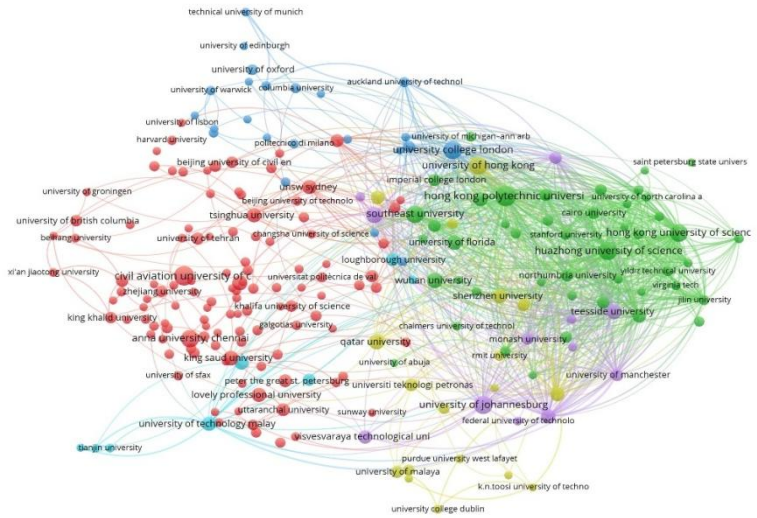

Fig 4. Organization Analysis

2.5 Country Analysis

VOSviewer's country analysis focuses on mapping and visualizing the research output and collaborations between countries, offering a global perspective on academic contributions and networks. By analyzing co-authorships, citations, and shared research themes, VOSviewer identifies countries with the highest research impact and the most active international collaborations. It clusters nations based on their research partnerships and areas of focus, revealing global research trends, key contributors, and regions with emerging scientific influence. This analysis helps in understanding the geographical distribution of knowledge production, fostering international cooperation, and highlighting leading countries in specific fields of study.

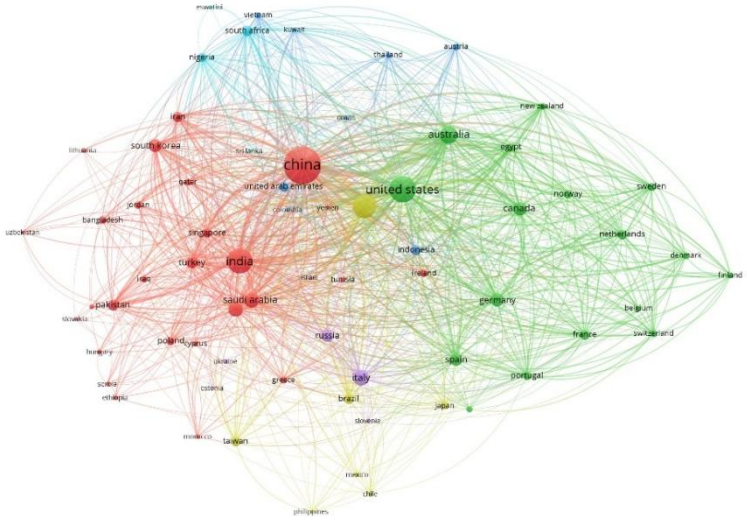

Fig 5. Country Analysis

2.6 Keyword Analysis

Keyword analysis using VOSviewer involves identifying and visualizing the most frequently occurring terms or phrases within a set of academic publications or documents. VOSviewer, a popular tool for bibliometric analysis, helps in mapping and clustering keywords to reveal relationships, patterns, and trends in research. By creating network visualizations, it enables researchers to see how certain keywords are connected, which topics are central, and how various research areas are interlinked. This analysis helps in understanding the intellectual structure of a field, emerging topics, and potential collaboration opportunities.

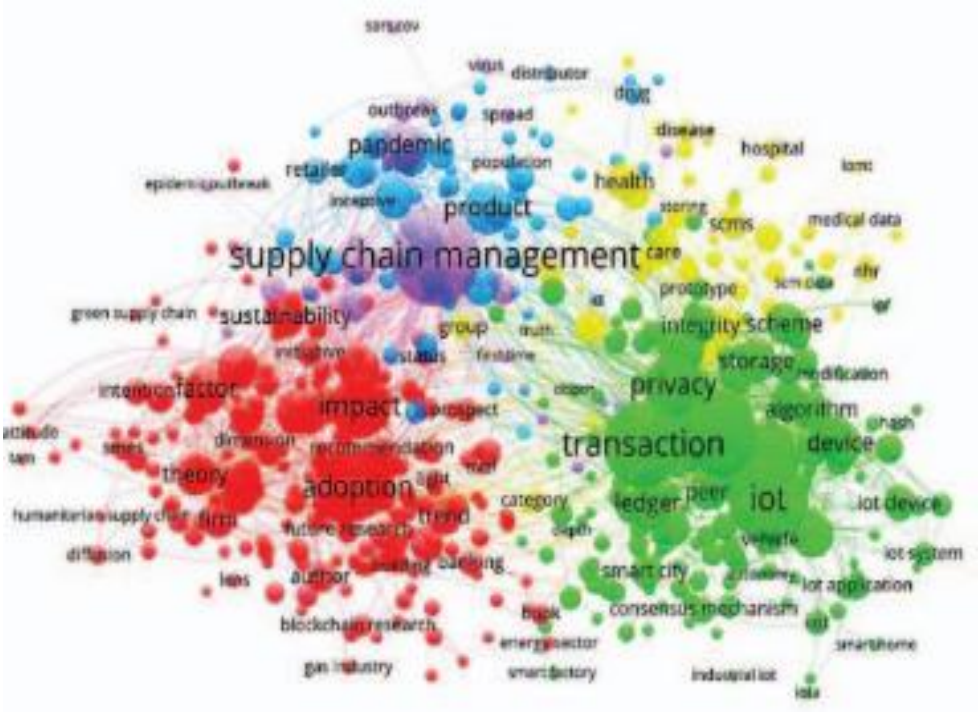

Fig 6. Keyword Analysis

3. Blockchain

Bitcoin is built on blockchain technology, which was introduced in 2008. Mining, in which users solve difficult arithmetic problems to create unique hashes for each block, secures the network of linked blocks. A block consists of three parts: a hash, a timestamp, and a header. For blockchain data storage, you only need 1 kilobyte of space, and making changes might cause the network to halt. Every node in the network validates and solidifies the data, transforming it into an immutable digital record. Blockchain technology enables users to exchange information and conduct transactions across an immutable network that is accessible to everyone.

3.1 Asymmetric Cryptography

Asymmetric cryptography, often known as public-key cryptography, secures and decrypts communications using two keys: one public and one private. Each person's keys are mathematically linked. You're right; no one else can obtain the private key. On the other hand, anyone can use the public key. One key cannot decrypt messages encrypted with another key, and the opposite is also true for message decryption. This signifies that two keys are required to complete an action. Digital signatures and receiver confirmation are the two main uses of asymmetric encryption. The first approach uses the sender's private key to encrypt data and the recipient's public key to decode it. This safeguards privacy by encrypting data using the receiver's public key and decrypting it using the same recipient's private key. Asymmetric encryption may be beneficial for key sharing, email security, and online security. Asymmetric encryption employs the ECDSA technique, the Secp256k1 elliptic curve, and the double-SHA hash to ensure that Bitcoin and other blockchain events are genuine.

3.2 Cryptographic Hash Functions

A hash function is a one-way function that can convert any amount of data into integers of a certain size. It provides permanent and irreversible pre-image resistance. Secure hash functions stand out for many reasons, including the avalanche effect, rapid processing, and collision resistance. Bitcoin employs the

256-bit SHA-256 hashing technique, which is quick and inexpensive to calculate and is a member of the SHA-2 family. Because there are so many atoms on Earth, the procedure generates a staggering 2256 distinct message digests. SHA-256 serves a multitude of functions, such as validating digital signatures, hashing passwords, and executing secure socket layer (SSL) handshakes. Password hashing protects the hash value of a user's password, preventing unauthorised access.

3.3 Blockchain Definition, Characteristics and Structure

Distributed Ledger Technology (DLT) makes it simpler and safer to retain records and transactions by separating them into blocks containing transaction data and timestamps. Cryptographic hash values, included in the next block's data, link these blocks together. There are hundreds of copies of the record dispersed among the network's nodes. It is their responsibility to examine the blocks that include transactions. Blockchain technology consists of four distinct components: distributed computing, crypto-chain, smart contracts, and node agreement techniques. After a series of transactions, a mining node will add the transaction information to a new block, which will also provide the block's hash value. This process generates a number of blocks, which subsequently travel to other nodes for verification. Each block adds its unique hash number to the subsequent block in the chain. In Bitcoin or a comparable system, a peer-to-peer transaction begins with a request and a secret key. The request is then verified and sent to other machines. The first machine to solve the "Proof of Work" problem receives bitcoin and adds their block to the main chain.

3.4 Proof of Work

When dealing with blockchain networks such as Bitcoin, hashing becomes more difficult because miners must append a nonce to the block header in order to reduce the hash number below a specific threshold. According to the "proof of work" (PoW) idea, this approach works because members of an autonomous network must strive to prevent undesirable actors from dominating it. The Bitcoin network has around 160 million TH/s of computational power, which is 160 EH/s, or 9.59309·1022 hashes divided by 600 seconds. This is how long it took to create Block 712,650. It demonstrates how computationally intensive Bitcoin mining has grown, which has a significant impact on Bitcoin's carbon footprint. Miners compete to solve the cryptographic challenge first in order to identify the nonce that generates a target hash less complex than the block difficulty level. On top of transaction fees, the miner who wins each block now receives 6.25 BTC in compensation. Once "mined," 21 million bitcoins will become usable.

3.5 Proof of Stake: An Alternative to PoW

Validators are those who participate in blockchain networks and add events to the blockchain in return for payment. Power-of-Wall (PoW) devices need a lot of computing power, which consumes a lot of energy to check operations. However, there are several drawbacks to PoW, including scalability challenges, sluggish transaction speeds, and excessive energy use. One Bitcoin transaction requires as much energy as hundreds of thousands of VISA transactions, and the limit on how much it can expand is significantly lower than what is required on a global scale. Proof of Place (PoS) allows owners to deposit cash and check out newly created blocks. This grants them the right to vote. PoS is quicker, simpler, and better for the environment than PoW because it addresses security, scalability, and decentralisation issues simultaneously. Only a limited number of verified users can accept transactions and new blocks due to the autonomous nature of proofs of work and proofs of stake.

3.6 Merkle Tree

Bitcoin and other cryptocurrency networks use a tree structure known as a Merkle tree, which is similar but reversed. Each non-leaf node stores a transaction hash as well as the names of its offspring nodes. This technique allows for the speedy and safe validation of extremely massive data structures. Instead of receiving the whole blockchain, thin nodes may utilise the Merkle tree to verify specific transactions. In a Merkle tree with 1,000 transactions, it only takes roughly 10 hash results to verify a single transaction.

3.7Advantages of Blockchain in Construction Industry

Blockchain technology has enormous benefits for the construction sector by increasing transparency, security, and efficiency in project management. It allows for real-time material tracking, secure and immutable contract and payment records, and workflow automation using smart contracts. Blockchain reduces disagreements by providing a single source of truth for all parties, resulting in increased responsibility. Furthermore, it guarantees the validation and recording of transactions in a decentralised, tamper-proof ledger, thereby reducing fraud and payment cycle delays, leading to more effective project delivery and cost savings.

4. Application of Blockchain Technology

4.1 Building Information Modelling

Blockchain technology has the potential to significantly enhance Building Information Modelling (BIM) by giving accurate and up-to-date information in real time. This identifies who owns the BIM models, making future research and responsibilities easy. Bimchain, a blockchain technology effort, aims to accelerate BIM adoption in the construction sector by combining BIM software with methods for tracking data movements. However, due to its lack of legal evaluation, the technology remains unusable in real-world scenarios. Blockchain technology might improve the BIM working environment by making it simpler to identify who owns data, keep networks secure, manage permissions, and store data consistently. It may help address some critical problems such as how to keep data secure and how to trust IT systems. We proposed combining blockchain technology with building information modelling (BIM) for autonomous architectural design to enhance trust and collaboration. We proposed an integrated digital twin and blockchain system as a solution to enhance the responsible exchange of information about construction projects. A new technology called BCBIM simplifies the process of checking BIM data for previous modifications. Blockchain technology in a mobile cloud environment facilitates the exchange of large amounts of data.

4.2 Smart Contracts

The "if/then" mechanism in smart contracts automates the process of creating contracts and payments, saving both time and money. Milestones may help them eliminate intermediaries by determining liability and payment due dates. Researchers found that blockchain-based independent smart contracts could potentially tackle the problems associated with centralised control systems and guarantee their implementation. Another application could involve automatically funding the development of a construction project, thereby eliminating costly management expenses. Late payments, nonpayment, extended payment periods, and excessive borrowing charges are just a few of the construction industry's financial issues. Blockchain technology and smart contracts might assist in addressing these concerns. Blockchain networks and smart contracts, when used to monitor building health, provide several advantages to structural engineAmong the benefits are the ability to verify authorities, the receipt of warnings for unusual activity, the immutability of data, protection from attacks, and the ability to conduct tracking searches.

4.3 Payment Management

Despite some issues, such as the fact that most people do not understand bitcoin, blockchain technology has been used to make supply chain financial transactions more transparent. It provides a detailed view into payments, making things flow more smoothly and allowing you to see how well the firm is doing financially. The blockchain-enabled smart contracts may help save time and money by reducing the need for human involvement. Researchers have combined smart sensors, building information modelling (BIM), and smart contracts with blockchain technology to make payments secure. Blockchain-based payment systems may make transactions permanent, traceable, and accessible to everyone. This might also benefit government initiatives. Crypto assets may help strengthen and solidify the relationship between money and commodity transactions. Automatic payment systems, airport sidewalk management systems, and progress monitoring on building sites are all examples of commercial applications.

4.4 Project Management

Because blockchain is autonomous, it may improve construction project management (CPM) by making it simpler to monitor tasks, their outcomes, and pay for them. Despite the construction sector's reluctance to adopt IT, blockchain holds significant potential due to its widespread use and ability to draw in capital and new businesses. A blockchain-based CPM platform's smart contract technologies facilitate peer-to-peer cooperation. This leads to improved information flow, reduced pricing, and higher-quality services. Blockchain technology may enhance productivity while eliminating issues with trust, verification, and transparency in five critical areas of project management: contract management, purchase management, finance management, asset and inventory management, and subcontractor management. Blockchain technology may not only reduce the centralisation of operations; it may also improve the reliability of logbooks, store data securely, and solve difficulties with building information management. For off-site modular house manufacturing, we provide a two-layer adaptive blockchain-based control approach.

4.5 Data Storage & Management

The construction industry is exploring the potential of blockchain technology for managing documents. Researchers aim to establish a network of interconnected devices to guarantee the security of data. A DLT

database will serve as the foundation for this network. This technology is used in large-scale BIM design engineering for distributed data storage. We advise construction professionals to use bitcoin to digitize building data for proper safety monitoring. Researchers are currently investigating the potential use of blockchain-powered robots for monitoring construction progress. Other innovative technologies include self-sovereign recognition systems, two-layer adaptive blockchain-based supervision models, and deep learning technologies for managing building tool security information.

4.6 Smart Cities

Many governments around the world prioritize smart cities because they improve people's lives and make cities more livable. Blockchain technology might benefit cities by making things more open, secure, resilient, and hard to modify. Civil engineers might find new work in smart cities by using methods such as blockchain, data visualization, big data analytics, sensors, data transmission, citizen science, and crowdsourcing. Because blockchain logs essential actions in an immutable, unambiguous, and up-to-date manner, it may aid in the prevention of poor civil engineering practices. Using blockchain technology in conjunction with Building Information Modelling (BIM) could potentially lead to more environmentally friendly dwellings. Using blockchain smart contracts for care and services might be a simple approach to improve smart building safety, automation, and transparency. Smart contracts and blockchain technology have the potential to improve the transparency and flexibility of smart building entrance control. This would make entering the structure safer.

4.7 Sustainable Environment

People are using new technologies like artificial intelligence and blockchain to fight climate change and foster long-term prosperity. Balasubramanian et al. developed a comprehensive ecological plan for construction 4.0 for the UAE's building industry. They came to the conclusion that the benefits far outweigh the drawbacks, and the UAE government is actively pushing citizens to use blockchain technology.Blockchain technology tracks the energy and material use of a material to determine its potential for recycling or other uses in the built environment. We developed a blockchain-based information management system to ensure a consistent and reliable method for rating the proportion of recoverable material in construction waste. The construction industry is also utilising blockchain technology to monitor the environment and reduce carbon emissions. The potential applications of Distributed Lean Manufacturing (DLT) in sustainable construction. They investigated infrastructure data management, sophisticated applications, consumer demand and preferences, taxes and reporting, and DLT. Blockchain software to monitor supply chain assets in order to reduce waste and advance the circular economy.A smart city application is a system for distributed energy production and sustainable rubbish management that makes communities smarter and more connected.

4.8 Facilities Management

Property management is increasingly utilising blockchain technology to collect renter data and ensure their comfort. According to research, a blockchain-based Internet of Things (IoT) system might enhance building services and increase tenant satisfaction with the IEQ. Digital technologies like BIM, the Internet of Things, and bitcoin may also aid with controlling assets and maintenance. The SSI-based system improves construction information management by simplifying procedures, enhancing data provenance and sharing, and making it easier to examine and validate certified information. It achieves this by merging blockchain technology with BIM, SSI, and internet of things (IoT) devices.

4.9 Supply Chain Management

Because the construction and planning processes do not employ the same techniques, operations, or services, there is a discrepancy in the correct information accessible between them. Blockchain technology may be able to assist with these difficulties by making transactions more transparent, settling payments more rapidly, organising materials, managing compliance, and tracking items. The implementation of smart contracts enables the rapid purchase, monitoring, and confirmation of items across the supply chain. SCM exchanges rely heavily on trust. Blockchain technology has the potential to increase trust while also protecting against the risks and expenses associated with pursuing collaborative possibilities. On the other hand, people's receptivity to alternative governance structures determines the proliferation and effectiveness of blockchain technology. Numerous studies have explored the potential applications of blockchain technology in the building industry. Asset tokenisation, project bank accounts, and reverse auction-based bidding are among the most researched topics. Blockchain technology may address CSC difficulties while also improving sustainability, boosting solidarity, and making information sharing simpler.

4.10 Design Construction

Adding blockchain technology to construction Information modelling (BIM) improves planning and construction processes by making them more transparent, trackable, and collaborative among many stakeholders. Digitalisation and the Internet of Things (IoT) have made it simpler for people to collaborate and exchange data by collecting less data throughout building design, construction, and operation. We have developed blockchain-enabled IoT-BIM solutions to control manufacturing overseas and construct modules. We have developed blockchain-enabled digital twin applications to improve both cyberphysical operations and the accuracy of information exchange. Blockchain technology liberates AI models from control, enabling you to scrutinize and verify the decision-making process. Blockchain BIM has made it simpler to transfer information and meanings across systems, facilitating audits, design management, and review. Smart contracts, financing infrastructure, and the elimination of intermediaries in the trust-building process are among the ways in which blockchain technology delivers projects. Blockchain technology holds the potential to enhance transparency in design review and administration, protecting rights and enabling individuals to track modifications made to documents.

4.11 Project Risk

Researchers suggest incorporating asset monitoring into blockchain technology to tackle issues related to transparency, cost, and dispute resolution. The SSI-based system streamlines digitalization processes and guarantees adherence to technical regulations and norms. Blockchain technology has the potential to improve and secure the modular building inspection process. This is critical during the COVID-19 outbreak. Blockchain technology improves project management by allowing for more flexible negotiations, cheaper transaction costs, and preventing anyone from modifying data. Some of the applications for blockchain technology include monitoring project expenses and modifications, betting on and forming contracts, and analysing purchases. McNamara and Sepasgozar's conceptual framework for intelligent contract acceptance demonstrates that blockchain-based Contracts have the potential to significantly transform the construction industry. Blockchain will quickly become an important tool for quality management. The "Product Organisation Process (POP) Quality Chain" system uses blockchain technology, smart contracts, and authorisation mechanisms to manage construction quality information. Hamledari and Fischer's development of blockchain technology for decentralised quality information management contributes to the security and consistency of procedures. Wu et al.'s experimental approach may facilitate on-site assembly of modular structures, which might be beneficial.

4.12 Real Estate

In 2017, professionals handled assets worth around $8.5 trillion. This demonstrates how crucial the real estate industry is to the economy. However, the industry has remained relatively unchanged over the past several decades because it continues to employ traditional methods of record-keeping and doing business. Standard models include drawbacks such as limiting foreign investment, taking a long time to verify, and involving a small number of individuals. Blockchain technology holds the potential to revolutionize the real estate industry by establishing digital records of ownership and transactions that remain unmodifiable on a public ledger. Since it is non-modifiable, it can verify title and simplify transactions, thereby reducing costs. Blockchain technology can also track building data and information as it progresses through the building's life cycle. It may keep track of all asset transactions in real time, making it easier to monitor things and get the facts and information you need. With this digital record of transactions, stakeholders will be able to demonstrate who owns what, make things clearer, and prevent fraudulent efforts. Digitising land records is another potential use for blockchain technology. This may inspire governments around the world to implement their own property registration systems. Real estate tokenisation may enable consumers with smaller bank accounts to enter the market by addressing liquidity and capital generation issues. The technology might simplify the process of trading in and borrowing money for overseas real estate, as well as eliminate the need for brokers. Blockchain technology has the potential to make it simpler for more people to live in shared houses by eliminating intermediaries and saving money and time. Blockchain technology has the potential to significantly improve the process of purchasing and selling real estate, as well as transform the industry.

5. Adoption Considerations and Challenges

Adopting blockchain in the construction business raises various questions and obstacles. One critical challenge is the need for industry-wide standards and coordination, as blockchain's efficacy is dependent on all stakeholders consistently adopting it. Smaller businesses may face challenges such as high initial implementation costs, technical knowledge, and integrating blockchain with current systems. Moreover,

we need to address concerns regarding data privacy, scalability, and energy consumption in certain blockchain systems. Regulatory ambiguity and opposition to change from conventional methods impede wider adoption, necessitating clear governance and specialised solutions for the sector.

6. CONCLUSION

Civil, architectural, and construction engineering are expected to have a substantial impact on blockchain technology in the future. The World Economic Forum predicts that by 2025, blockchains will account for approximately 10% of the global GDP. Industry experts agree that blockchain technology has the potential to improve efficiency, sustainability, and security across a broad range of industries, perhaps leading to global regulatory and legislative reforms.The goal of this study is to look at the complexity of blockchain technology in the sectors of construction, architecture, and civil engineering, as well as its fundamental principles and characteristics. This article focusses on six key areas of application: computer-aided design (CAD) and building information modelling (BIM), contract management, smart contracts, construction project management, smart buildings, smart cities, and supply chain management in the construction industry, as well as real estate services like property ownership, asset management, and maintenance.

Despite several challenges, blockchain technology is poised to drastically revolutionise the long-term planning, design, execution, and maintenance of building projects. An examination of 109 journal articles published between 2018 and 2022 that focused on blockchain technology in the construction sector revealed a rising trend in publishing. The United States of America, China, and Hong Kong made the most significant contributions based on affiliation. The implementation of smart contracts was the most widely reported use of blockchain technology.Utilise the security, immutability, transparency, auditability, traceability, and reliability that blockchain technology provides to enhance the construction industry's sustainability, safety, and accountability. Addressing these issues could lead to advancements in quality, safety, and sustainability within the construction industry. This will also assist in fostering accountability and trust among stakeholders.According to the study paper, there are many barriers to widespread use of blockchain technology. These challenges include a lack of technical expertise, resistance to change, and ambiguous legal and regulatory frameworks. Training and education, new policies, a regulatory framework, and industry standards may all help to overcome these barriers.

Future Scope

The future of blockchain in the construction sector seems bright, with the potential to transform project management, contract execution, and supply chain transparency. We expect improvements in scalability, energy efficiency, and user-friendly interfaces as the technology advances, making blockchain more accessible to all industry participants. Integration with new technologies like IoT and AI might improve real-time tracking, predictive maintenance, and automated quality assurance. Over time, we anticipate the development of regulatory frameworks to facilitate their greater use. Blockchain might eventually allow entirely digitalised, decentralised project ecosystems, boosting efficiency, lowering costs, and increasing confidence in the building industry.

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