Smart Cities Development using Blockchain Technology in India: A Critical Analysis

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Abstract

Indian cities are facing enormous challenges due to population growth and rapid urbanisation. Every citizen's lifestyle is getting impacted. People move from rural areas to urban cities in search of employment, education, safety and security, better healthcare options. Blockchain technology mixed with the notion of a "smart city", could prove to be a boon in addressing these urban city problems, by providing a better living environment, and constructing a long-term sustainable solution [1]. The goal of this study is to consolidate existing knowledge on the topic, analyse current and continuing research developments, and show the way for future investigations using a rigorous and auditable systematic review technique. 146 papers published between 2018 and 2023 in 82 journals examined as part of bibliometric analysis. The study created and visualized the literature's bibliometric networks using citations and analysis of co-citation, co-occurrence network of keywords, journals, authors, and nations. The findings showed that there has been an exponential increase in recent years in the number of research articles explicitly focused on blockchain and smart cities. This paper also explores how blockchain technology might apply to smart cities.

Keywords

Environment, Smart City, Blockchain Technology, Urbanization, Infrastructure

1. Introduction

There has been a substantial increase in the urban population during the past few decades. The report titled "World Urbanization Prospects" predicts that by the year 2050, 65 percent of people will live in cities, which is an increase from the current percentage of 54 percent; however, only 46 percent of people currently live in communities. [2]. The number of people living in cities in developing countries in Asia and Africa grows faster than in other parts of the world. China's urbanization level went from 38% in 2001 to 56% in 2015 [3]. In different areas, including wellness, education, mobility, economic improvement, living environment and employable conditions, urbanization has significantly improved the standard of living for people around the world. Moreover, the rapid urbanization of the globe also brings with it novel issues and challenges. Due to the high population density in urban areas, environmental resource constraints, traffic problems, poor air quality, releases of greenhouse gases, and improper disposal have affected the life expectancy of urban residents. [4]. All these difficulties and issues compel city dwellers (such as officials and residents) to focus on more intelligent strategies for the development of cities sustainably and the enhancement of the quality of life of their inhabitants. The concept of a "Smart City" is being introduced in this context. [4] [5].

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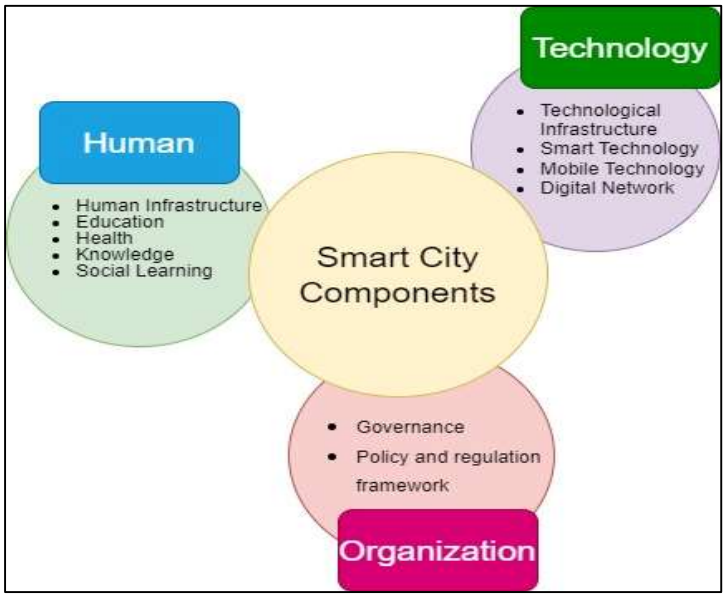
What does the term "smart City" refer to exactly? A "smart city" commonly defined as an urban area that leverages advanced communication and information technology to offer inventive solutions aimed at enhancing the overall quality of life and establishing an environmentally sustainable environment. This definition has gained widespread acceptance.[6]. Some of the features that define a "smart city" include efficient use of resources, an advanced transportation network [7], cutting-edge healthcare facilities[8], effective waste management systems [9], and top-notch educational facilities [10]. Smart cities represent urbanization's next stage. [11].

Figure 1: A conceptual framework of smart city



Source: Author's compilation

Smart cities largely depend on advanced technology and complex networks to operate properly, as stated by [12] and [13]. Government services such as health , safety and security, and the city's larger infrastructure (such as public transportation, emergency services, and energy grids) all work together seamlessly in a "smart city" [14]. Information Communication Technology is essential for implementing smart cities. Several strategies for developing innovative and environmentally conscious cities have been proposed in recent years. [15][16]. These techniques helped the governments and authorities take action, make judgements, and monitor urban expansion[17] but India has a long way to go.

Blockchain is very crucial to the success of smart and intelligent cities. Blockchain, as defined by[18], is "a digital, decentralised, and distributed ledger in which transactions are logged and added in chronological order with the goal of creating permanent and tamperproof records." Blockchain initially implemented by S. Nakamoto (2008). It is distributed database and decentralised transaction technology [19]. Despite cryptocurrencies, blockchain technology presently recommended for use in a variety of application fields due to its robustness and data security. Subsequently, there has been a surge in interest about the utilization of blockchain technology in diverse sectors. The security and decentralization of transactions initiated through blockchain arise from the distribution of transaction records across the network, enabling access, transmission, and verification by any participant within the system. Researchers and observers have suggested "blockchain cities" as the key to upgrading metropolitan cities to address urbanization concerns. Many believe blockchain technology will boost the nation's economy and quality of life.[20].

The present study addresses the existing gap in knowledge by conducting a comprehensive bibliometric analysis of blockchain research with respect to smart city. The aim of the investigation is to identify areas of insufficient knowledge in this field and to assess the influence of literature in the scientific database of Scopus during the period from 2018 to 2023. The analysis encompasses co-citation analysis, as well as the examination of keyword co-occurrence networks pertaining to publications, authors, journals, and nations. During the literature study, in addition to conducting a bibliometric analysis of the database, the author also endeavoured to address the below mentioned Research Questions (RQs).

Q1 In what manner Blockchain contribute to smart city development?

Q2 In what ways these major obstacles prevent Smart Cities from fully embracing Blockchain Technology?

Q3 How can we help communities use Blockchain Technology so that they can become more sustainable and technologically advanced??

The following is the outline for the paper:

The literature reviewed in Section 2, followed by a description of the research techniques used in this study in Section 3, and finally, a thorough discussion of the results in Section 4. The bibliometric analysis summarized in Section 5, and the comments and potential future research discussed in Section 6. The conclusion discussed in Section 7, and future scope of research discussed in Section 8.

2. Literature Study

2.1 About Smart City

Since the terms "smart city" and "smart" have various meaning, academics, researchers, and business experts have shown a great deal of interest in this subject [21]. Examples include Digital City [22], Intelligent City [23], etc. (Pro et al., 2014) provides a comprehensive examination of the smart city, discussing its goals, research problems, and potential project area. According to [24] The primary objective of a smart city is to enhance the quality of life for its residents by the strategic use of innovative technologies that address many challenges, such as minimizing carbon emissions, alleviating traffic congestion, improving waste management, and tackling other pertinent concerns [25]. However, the rapid growth of population and globalisation make it difficult for the Indian government to find solutions that are both efficient and affordable to address the issues [26]. The functional prerequisites have been reviewed by [27]. The importance of information security in smart cities, as well as the related problems and solutions, are discussed in [28]. [29] found that although a city cannot be "smart" with few resources or modest sectoral shifts, it can be "smart" in every respect that matters administration, transportation, housing, lifestyle, environmental sustainability, and economic vitality. Contribution of every single part is essential, even though various approaches to creating an efficient smart city have been discussed in prior research, one of the most important characteristics is sharing [30]. Smart card utilization and a dynamic ID based verification technique is proposed as a means to authenticate distant users in a multi-server environment, with a specific focus on applications related to financial security, was proposed by [31]. They concentrated mostly on eliminating the server spoofing and forgery attacks that were present in the earlier systems. After logging in, they dynamically changed the user ID to prevent tracking and to give the user anonymity. Similar to this, [32] suggested a different authentication method for a remote user utilizing smart cards and biometric verification. Achieve efficiency, they substitute nonces for clock synchronization and employ the one-way hash function. Real-time applications, like Smart City, do not work with the above authentication methods. The Smart City needs to process data in real time, which means it needs a good security system that does not slow down the system.

Technology is key to the smart city framework. because it makes it easier to collect and analyse real-time data, resulting in smarter decisions and improved city management. Using big data in smart communities and other settings was investigated [33] to determine its potential, challenges, and actual advantages. The analysis of traffic-related concerns in smart cities has been extensively examined by [34] , and there have been discussions on innovative strategies for addressing these challenges. Machine learning, among other disruptive technologies, is widely employed inside contemporary traffic management systems, mostly in the stages of data collection and service delivery.

2.2 Blockchain Technology

The built environment industry is undergoing a complete transformation because of new disruptive technologies. In the future, blockchain technology may use to solve urban problems. and make a significant contribution towards the attainment of the United Nations Sustainable Development Goal at the municipal level. The advent of blockchain technology and its myriad potential applications have facilitated the development of intelligent urban centres and the resolution of associated challenges. Extensive research and investigations have been carried out pertaining to the field of blockchain technology. [35] provided a comprehensive presentation on the overview of blockchain technology, encompassing its architecture, applications, consensus algorithm, and forthcoming research problems and directions. According to a survey conducted by [36], blockchain technology has security concerns and challenges. The characteristics of the well-known cryptocurrency Bitcoin, its fundamental structure, and related applications were described in [37].

The author [38] conducted research on blockchain and showed how the technology can be useful for government-related tasks like citizen digital ID maintenance and data security. In their study, [39] examined the application of smart contracts in ensuring the security of real estate transactions conducted by buyers and sellers. Author outlined both the advantages and disadvantages of using smart contracts. In [2], the possible applications of blockchain technology to building information modelling (a subset of the construction management process) were investigated. The author draws the conclusion that construction information can manage more safely with a blockchain system. Hence, it is evident based on prior scholarly investigations that blockchain technology possesses the potential to provide diverse resolutions to the persistent challenges encountered in smart cities. The purpose of this article is to elucidate the significance of blockchain technology in the advancement of intelligent and environmentally conscious urban areas.

3 Research Methodology

3.1 Data gathering

Using bibliometrics, Author examined smart city blockchain applications. This form of review helps researchers synthesise prior findings and inspire novel studies. According to [40], bibliometric reviews are useful since they are unbiased and can reveal previously unknown aspects of the literature. Bibliographic techniques allow researchers to visualize the mental terrain of a subject of study, which clarifies and simplifies their findings. In the similar way the strength of bibliometric reviews, according to [41], lies in their capacity to recognise and categorise a large range of documents within a certain field and to make it easier to analyse data to highlight trends based on synthesized data.

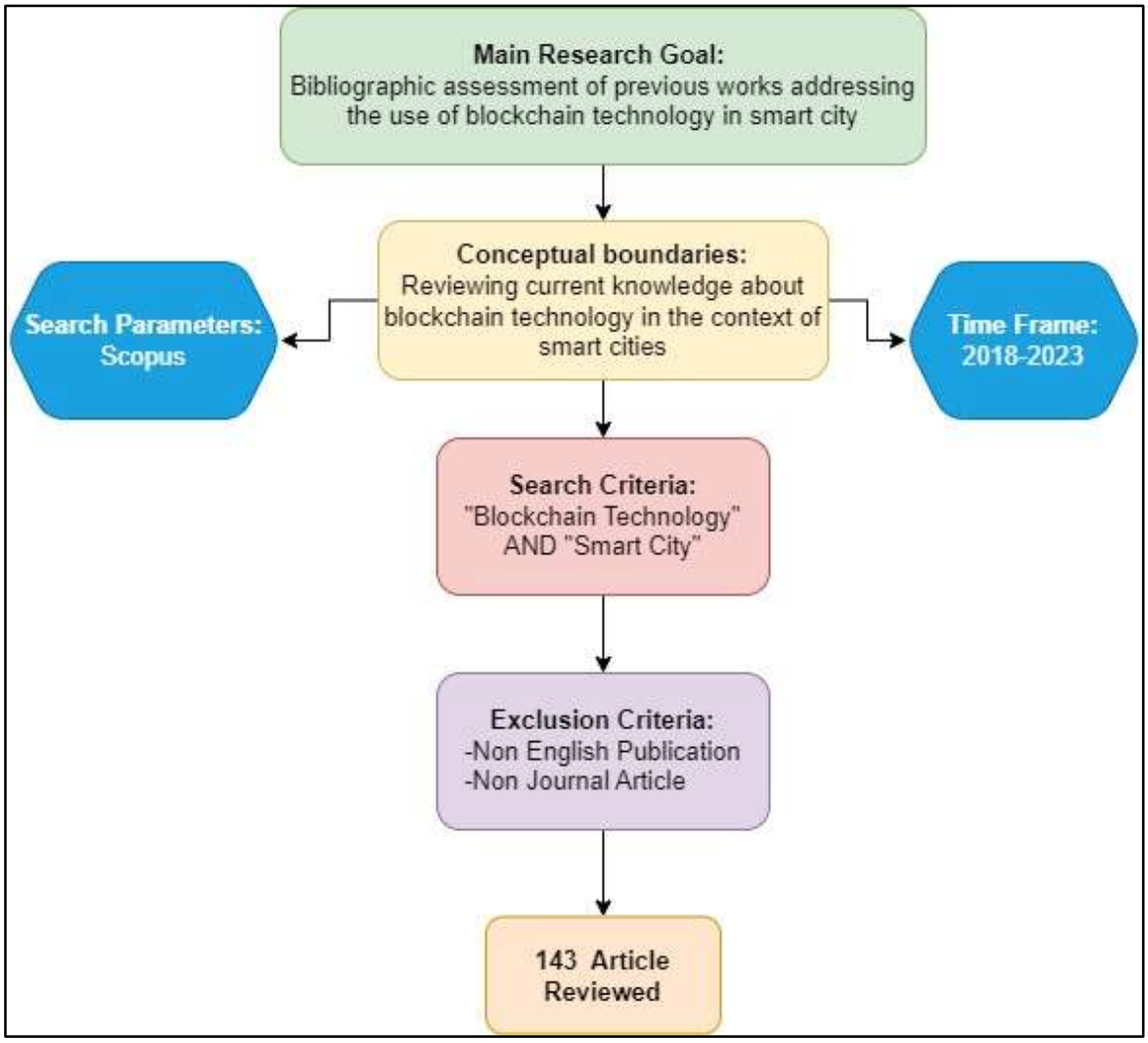
Finding an appropriate database for the study is the first step in the bibliometric review process. We searched the Scopus database to determine the papers to include. Scopus is a popular research tool because of its capacity to organize citations and track references in a wide variety of fields. Web of science has around 70% less sources as compared to the Scopus Index and is widely considered to be one of the best academic databases in the world [42]. When searching for relevant articles, the author combined the Boolean AND operator with the terms "Blockchain Technology" and "smart city" in the title, abstract, and keywords sections.

Using the framework of numerous studies as a starting point, the author analysed and constructed bibliometric indicators tailored to scholarly journal articles. This is because they provide a cross-sectional view of scientific endeavour around the world. Enhance the scope of the study, the author examined articles that published in the English language. The inclusion criteria encompassed the consideration of articles published between the time limit of 2018 to 2023 in scholarly journals. By using the established criteria, the database successfully refined, resulting in a reduced set of 160 items. The author limited the scope of

the study to specific disciplines, including management, accounting, computer science etc. to enhance the precision of the results. The disciplines received the highest level of focus. The quantity of articles decreased to 153. The title, abstract, and keywords of each article thoroughly examined to determine their relevance. A total of 143 journal papers identified for the ultimate evaluation and analysis.

3.2 Bibliometric Approaches

Figure 2:Review of Literature Framework



Source: Author's Compilation

Upon completion of the explanatory analysis, content of selected articles and article relationship reviewed in detail to obtain more insights. Network analysis also conducted to find the relationship network between blockchain and smart city by using one of the features of bibliometrics in RStudio.

A keyword co-occurrence analysis conducted using RStudio to ascertain the extent of research conducted on the topics of blockchain and smart cities within the specified temporal scope. This methodology aids in separating the realm of knowledge and revealing how many study directions interact with one another [43].

In contrast to the methodology of co-citation analysis, wherein references grouped together based on the strength of their connections, analysis of keyword co-occurrence network focuses on author-supplied keywords and investigates the frequency of their joint occurrence in published works.

[44] firstly developed Analysis of Co-citation. It was used to evaluate out and display some of the smart city research potential of blockchain technology. Researchers can gain a better understanding of the connections between co-cited sources by analysing previously analysed articles. Article co-citation analysis is a frequently employed method in academic research due to its reliance on the assumption that a relationship exists between two papers if both cited in subsequent research. When attempting to determine the scope of a body of knowledge, higher co-citation rates between publications are indicative of closer ties, more consistent referencing, and more shared understanding [45]. This article's co-citation network built in RStudio.

4 Findings

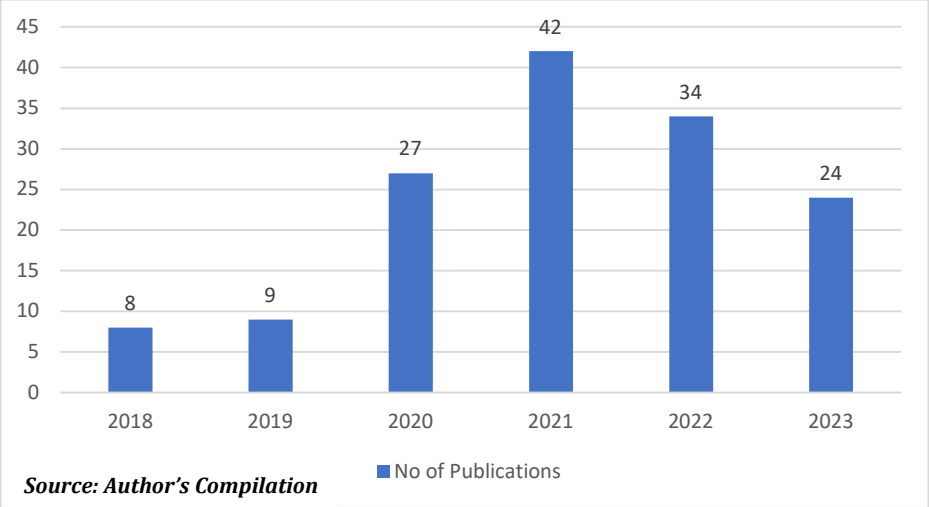
4.1 Yearly Publication Distribution

Table 1: ***Yearly Publication***

Year	Articles
2018	8
2019	`9
2020	27
2021	42
2022	34
2023	24

Source: Author's Compilation

Figure 3:Year wise publication



Source: Author's Compilation

The bar graph below shows the number of publications by year that derived from the Scopus database. It was found during the article search process that prior to 2018, not much research had done on blockchain and smart cities. The increase in the number of papers published each year was one of the reasons for starting in 2018. The number of papers released in 2020 increased considerably when compared to 2018 and 2019, as seen in Figure 3.

The development of multiple decentralized applications with a smart city focus and an increase in the number of academics willing to understand how to use blockchain technology to solve urban challenges are the two key factors driving this increase in interest [46]. It anticipates that there will be a substantial increase in the quantity of scholarly publications pertaining the use of blockchain technology in the future of smart city. This surge in publications expected to follow an exponential growth pattern, signifying the progression of adoption maturation. Furthermore, it anticipated that these topics would continue to attract significant academic interest and attention.

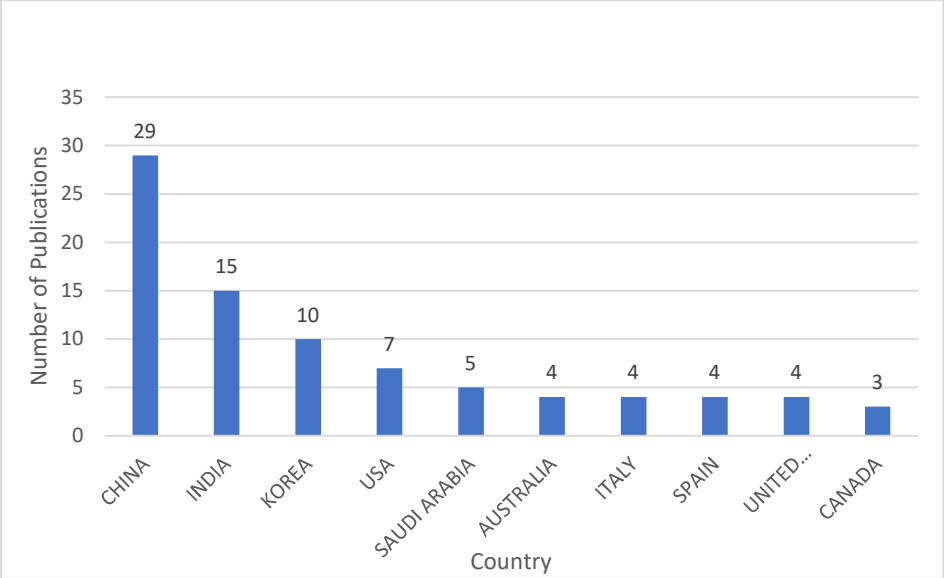
4.2 Country Specific Publishing Distribution

Table 2: Country Specific

Country	Articles
CHINA	29
INDIA	15
KOREA	10
USA	7
SAUDI ARABIA	5
AUSTRALIA	4
ITALY	4
SPAIN	4
UNITED KINGDOM	4
CANADA	3

Source: Author's Compilation

Figure 4: Publications by Country



Source: Author's Compilation

To extract the articles by country, the author affiliations have investigated. According to our literature review, China, India, and Korea have made considerable contributions to blockchain technology and smart cities research, with 29, 15, and 10, respectively. The fact that China has more than 300 smart city pilot programmes makes it evident [24]. Blockchain technology's contribution to many such projects can give citizens smart solutions, a high standard of living, and the ability to make educated judgements. China is also the first country to adopt blockchain technology for data authentication [47]. The announcement made by Prime Minister Narendra Modi in India regarding the Smart City Mission initiative, which seeks to establish one hundred smart cities that are both citizen-friendly and sustainable, has garnered attention from researchers, governments, and various stakeholders who are keen on highlighting the incorporation of advanced technologies like blockchain in the developmental endeavours. The Indian government has commenced the implementation of blockchain technology for vehicle registration, land transactions, and land record administration in the port city of Vishakhapatnam [48].

Since 2018, South Korea has made substantial contributions to blockchain research and its application to revolutionize business operations. South Korea has emerged as an early adopter of blockchain technology, employing it across sectors such as finance, logistic, intellectual property rights, trade, and healthcare. The South Korean government has made a number of measures, including implementing blockchain in tax law, educating people about the technology, planning to use it for military acquisitions, using it for administrative activities, and speeding up the loan application process. [49]

Over the course of the past decade, there has been a rapid surge in interest surrounding blockchain technology within the United States. Technology's use has expanded to include a vast array of fields, from finance and banking to government functions like auditing and tax collection [50]. A similar effort was launched in Chicago by the Cook County Recorder of Deeds to explore the feasibility of creating and managing digital property summaries via blockchain [46]. Improved public and private sector services, better citizen-government relations, and fundamentally secure and effective operation and commissioning of smart urban infrastructure are all goals of US state and local governments.

4.3 Journal Specific Publishing Distribution

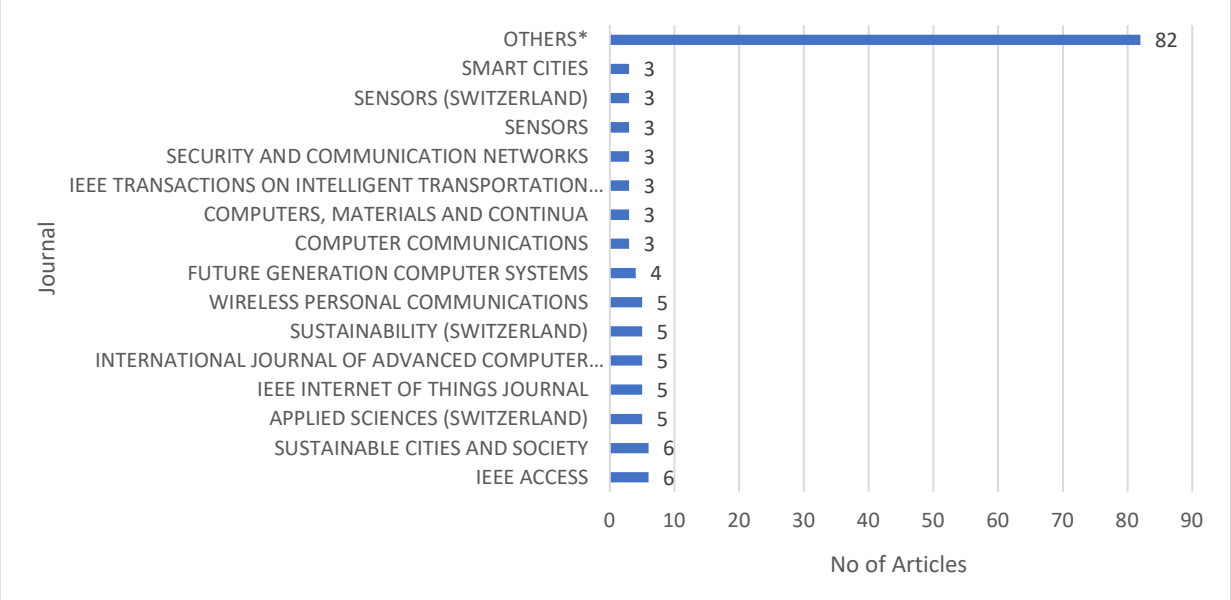
Journal publication counts displayed in figure 5. There is a total of 144 papers published across eighty-two journals (81), with IEEE and sustainable cities and society publishing the most (six each), followed by journals publishing 5, 4, or 3 papers.

Table 3: Journal Specific publication

Journals	Articles
IEEE ACCESS	6
SUSTAINABLE CITIES AND SOCIETY	6
APPLIED SCIENCES (SWITZERLAND)	5
IEEE INTERNET OF THINGS JOURNAL	5
INTERNATIONAL JOURNAL OF ADVANCED COMPUTER SCIENCE AND APPLICATIONS	5
SUSTAINABILITY (SWITZERLAND)	5
WIRELESS PERSONAL COMMUNICATIONS	5
FUTURE GENERATION COMPUTER SYSTEMS	4
COMPUTER COMMUNICATIONS	3
COMPUTERS, MATERIALS AND CONTINUA	3
IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS	3
SECURITY AND COMMUNICATION NETWORKS	3
SENSORS	3
SENSORS (SWITZERLAND)	3
SMART CITIES	3
OTHERS*	82

Source: Author's Compilation

Figure 5:Publication by Journal



Source: Author's Compilation

There are less than three publications in the "Others" category that discuss the intersection of blockchain technology and smart cities in seventy-one (71) journals. A detailed investigation from the journals revealed that

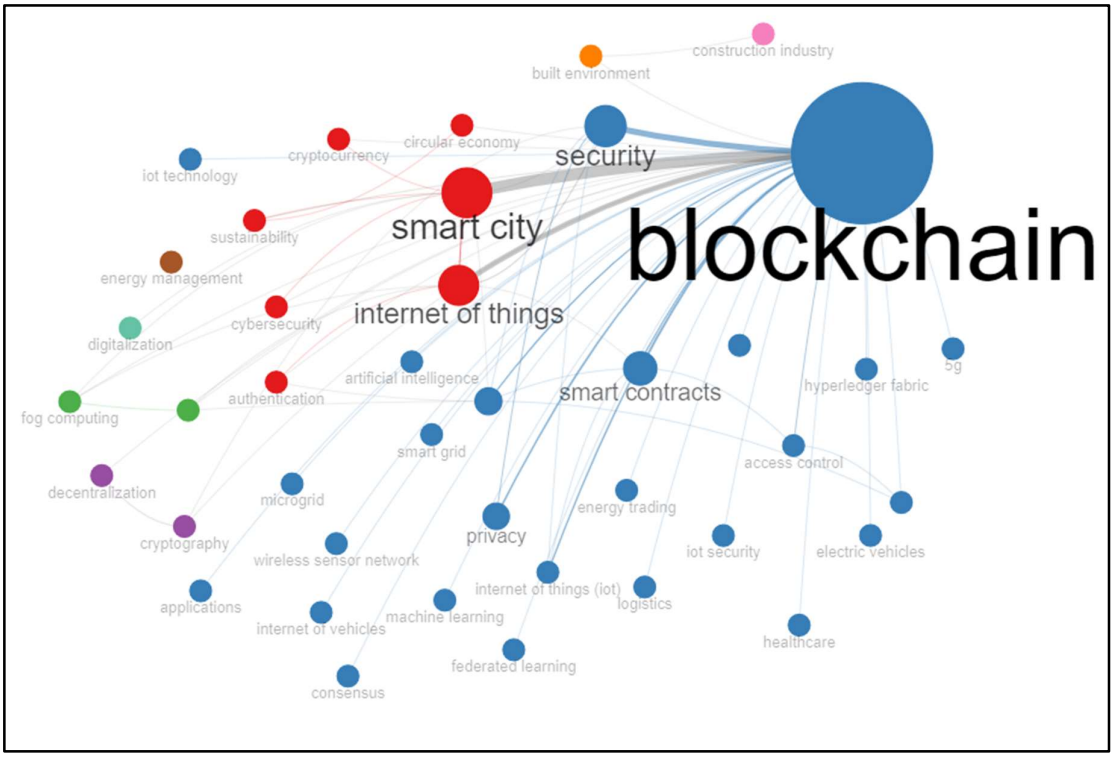
blockchain technology and smart city have widely practiced by engineering and computer science professionals. These professions have published papers in highly repute journals having high \h index.

Fewer papers published in journals that focus on management, urban science, and the social sciences. We discovered that low output in such journals is typically the result of either a lack of submissions or a high rejection rate for papers that do not adhere to the journal's stated aims and objectives.

5 Bibliometric Analysis

5.1 Association network for keywords

Figure 6: Keyword Co-occurrence



Source: Author's Compilation

Scholars can benefit from an analysis of keyword co-occurrence by learning which topics have attracted the most interest. Keyword co-occurrence, according to [51], is a scientmetric technique that visualizes often co-occurring terms or subjects in the literature.

This strategy aids the researcher in comprehending the paper's content, the paper's overall scope, and other crucial details like the research's techniques and goals. Create the co-occurrence network, the author pre-adjusted the original keywords as needed. The terms "smart city" and "smart cities," "blockchain" and "blockchain technology," and "IoT" and "Internet of Things" are few examples of related terms that combined. As illustrated in fig 6 total forty (40) nodes appearing in the co-occurrence network and 6 keywords were combined which were common. There is a positive correlation between the size of a node and the frequency of the keyword's recurrence in the literature. Authors frequently utilize blockchain, smart city, security, and internet of things as keywords. Below table depicts the most frequently used keyword by the author in major 5 clusters.

Table 4: Top 5 keywords per cluster

Rank	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5

1	Blockchain	Digital Storage	Data Privacy	Smart City	Smart Power Grids
2	Internet of Things	Network Architecture	Machine Learning	Information Management	Deep Learning
3	Network Security	Fog Computing	Privacy and Security	Sustainable Development	Data Analytics
4	Authentication	Software Defined Networking	Engineering Education	Decision Making	Smart Contract
5	Cryptography	Green Computing	Sensitive Information	Energy Utilization	Decentralised

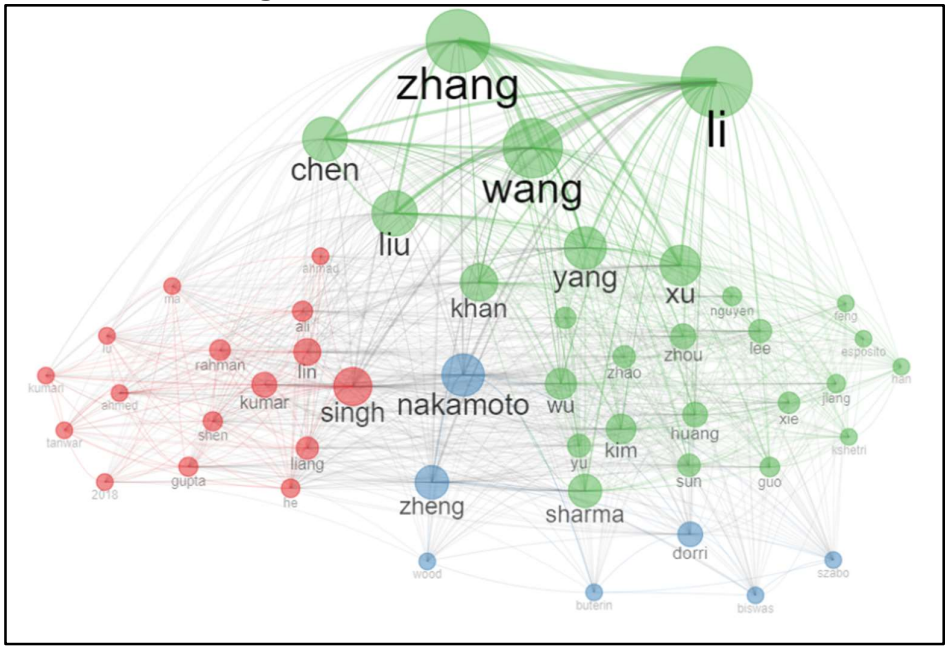
Source: Author's Compilation

5.2 Network of Article Co-Citations

The article co-citation network considered the most prominent form of co-citation analysis. The initial proposition of this methodology was put forth by [44], where the author suggests looking at the network of sources that are cited together. The suggested approach utilizes articles as fundamental components of network analysis, while co-citation clusters serve as representations of the underlying conceptual structures underpinning the field. By applying co-citation methods, researchers can learn both about the characteristics of the referenced articles within a cluster and the relationships between clusters. The intention of this research was to undertake a co-citation analysis of blockchain and smart city-related articles to better understand the framework of the most significant contributions to this field of study. Article co-citation network results from RStudio bibliometric analysis presented in Figure 7. The pair of articles that exhibit a high degree of co-citation identified by the presence of thick arcs. The occurrence of co-citation refers to the situation in which two articles co-cited concurrently within a single article. The existence of dense arcs indicates a strong association between these articles, suggesting common attributes related to topics [44]&[51].

However, thin arcs indicate a poor correlation between publications which cited together and the absence of content similarity. A thick arc, such as the one between Zang and Li, indicates that the two publications are highly co-cited and discuss related topics. Both wang and Li follow a similar trend. The narrow line connecting Yang and Xu indicates a low co-citation strength and, by extension, a lack of content similarity between the two groups. Only 50 of the most frequently referenced (based on a minimum of two citations per article) are included in Fig. 6 of the co-citation network.

Figure 7: The co-citation network of articles



Source: Author's Compilation

6 Review and Future Research Implication

Based on our research, we can conclude that blockchain technology research has evolved significantly in the last few years. The rapid advancement of technology has led to the emergence of applications that significantly impact the planning and management of "smart cities.". Scholars, professionals, and governments all over the world are putting a lot of effort into studying how blockchain can be used in smart cities. Several examples of the smart city uses of blockchain technology were presented. Since their inception, smart cities have benefited from the rapid evolution of IoT technologies and the widespread availability of big data. These advancements have transformed many industries, including healthcare, transportation, education, energy, and services, but they also pose security vulnerabilities [52], apprehensions regarding privacy [53], and technical inefficiencies [54].

6.1 Contribution of Blockchain Technology to the development of smart Cities

The development of "smart cities" could benefit from the use of blockchain technology. This has a wide range of potential uses, from public service monitoring and administration to supply chain tracking and voting system security. For example, blockchain can used to track and manage the distribution of renewable energy in a smart city, enabling the reduction of carbon impact and more effective use of resources. Furthermore, blockchain-based voting systems can offer transparent and safe election procedures. [55].

The utilization of blockchain technology in smart cities demonstrated by Dubai's "Blockchain Strategy," which aims to establish Dubai as the first-ever blockchain-driven government globally by the year 2020. The proposed approach encompasses the utilization of blockchain technology in a diverse range of government functions, such as bill payments and visa applications [56].

Data exchange: Smart cities can securely and transparently manage and trade data using blockchain technology. Blockchain can track public services like energy and transportation. Blockchain provides a secure, transparent ledger of transactions, improving supply chain management [57].

Digital identity management: The implementation of blockchain technology enables the establishment of an immutable digital identity, which possesses the capability to be utilized across a diverse range of services such as banking, elections, and governmental functions [58].

Smart contracts: Using blockchain technology, procedures and transactions between parties can be automated, including lease agreements for real estate and energy trading. [59].

IoT integration: To enhance the efficiency of data collecting and management, the integration of blockchain technology with Internet of Things (IoT) devices, such as smart meters and sensors, can be employed [60].

Decentralized energy grid management: By eliminating the need for intermediaries and increasing market efficiency, a decentralised energy grid management system based on block chain technology will allow people and businesses to purchase and sell energy directly from one another.

6.2 Barriers in implementation of blockchain technology

India's smart cities confront several challenges when implementing blockchain technology, including the following.

Regulation: The absence of clear and comprehensive guidelines pertaining to the utilization of blockchain technology poses a significant barrier to its implementation within the smart cities of India.

[61]. The government and relevant organizations participating in blockchain technology should establish precise guidelines and a comprehensive legal framework to facilitate the seamless integration of blockchain technology in smart cities.

Technical: Before blockchain technology can be used in smart cities, three technical issues—scalability, interoperability, and security—must be resolved. [34].

Scalability: To manage the enormous amounts of data that smart cities generate efficiently, blockchain technology must be able to scale. Scalability is a major problem for blockchain technology because the current technology cannot handle many operations per second.[62]. Scalability is improved by expanding network capacity, which requires adding more nodes to the blockchain network. The network is said to be more scalable if more nodes can fit within it.

Interoperability: Smart cities require technology that can interface with other systems and technologies for blockchain technology to be effective there. Interoperability is a challenge for blockchain technology since multiple blockchain platforms use different protocols and technologies [63]. One potential approach to mitigating interoperability difficulties involves the establishment of shared standards and protocols, which can facilitate seamless communication between blockchain technology and other networks.

Privacy and security: Because blockchain technology is a decentralised system, it can be challenging to keep data confidential or secure. Sensitive data is used by smart cities, so it's crucial to make sure that this data is kept private [20] [64]. The government needs to develop cyber security standards and provide suitable guidelines on data protection and security. The government should also encourage enterprises to follow the rules when using blockchain technology.

Integration: Blockchain technology integration with the infrastructure and systems already present in smart cities can be a challenging and time-consuming procedure[60]. Choosing the appropriate blockchain platform might aid in mitigating the challenges associated with integration. Thoroughly evaluating the integrated system can also help mitigate this issue. The implementation of a change management plan can facilitate the adoption of new technologies among employees through the provision of comprehensive training.

High implementation costs: For cities with limited resources, the high implementation costs of blockchain technology can be a major roadblock to adoption[65]. It is imperative to perform a cost-benefit analysis prior to implementing a technology to assess the prospective advantages in relation to the expected costs. The utilization of open source blockchain platforms can effectively mitigate development costs, resulting in a reduction of implementation expenses while maintaining the integrity of privacy and security measures.

Lack of knowledge and comprehension: It can be challenging to adopt blockchain technology successfully since there is a lack of knowledge and comprehension about it among citizens and government officials. It is recommended that both governmental entities and private groups undertake workshops, awareness programs, and educational talks to emphasize the significance of blockchain technology and its potential for efficient implementation in the development of smart cities.

6.3 Steps to adopt Blockchain Technology

Education and awareness: cities can offer training and education initiatives to assist businesses and residents in realizing the advantages and applications of blockchain technology.

Cities can conduct pilot projects and proof-of-concepts to show how blockchain can used in real-world contexts for things like energy management, supply chain traceability, and smart contract automation.

Cities can work together to develop and execute solutions by forming partnerships and collaborations with blockchain start-ups, businesses, and research organisations.

Policy and Framework: Cities can build a policy and legal framework that is favourable to blockchain innovation by, for example, setting up sandboxes for testing and experimentation[61].

Integration with current systems: To ensure a seamless integration and implementation, cities can combine blockchain solutions with current systems and infrastructure[60].

Promote citizen participation: Cities can work with residents, communities, and other stakeholders to jointly develop solutions that address their needs and priorities and promote citizen involvement in the adoption process.

Cities can experiment with various use cases, such as traceability solutions, decentralized markets, and smart-contract-based automation, to see how blockchain technology might applied to their requirements.

7 Conclusion

The transparent and readily accessible data management and sharing platform offered by blockchain technology has the potential to make substantial contributions to the intelligent and sustainable development of urban centres in India. Supply chain management, secure voting systems, and the monitoring and administration of public services are examples of applications for blockchain technology. The integration of blockchain technology in smart cities offers numerous advantages, such as optimized resource utilization, reduced environmental impact, implementation of smart contracts, integration with the Internet of Things (IoT), management of decentralized energy grids, digital identity management, and various other benefits. However, Indian smart cities struggle to utilize blockchain technology due to a lack of regulation, technical issues, expertise and comprehension, high implementation costs, and system integration. Cybersecurity and privacy are also important.

It is necessary to find solutions to these problems for the blockchain technology successfully implemented in the smart communities of India. Governments, IT businesses, and researchers must work together to solve these problems and use blockchain technology to improve city life and reduce environmental impact. The government can begin blockchain deployment in smart cities by creating rules and legislation. They might also participate in research and development activities to find solutions to the technical challenges that arise when putting blockchain technology into practise. Companies in the technology sector and researchers in this field can also contribute by developing blockchain-based solutions that are more scalable, private, and user-friendly.

To achieve sustainability and intelligence in Indian cities, it is imperative to gain a comprehensive understanding of the possibilities of blockchain technology and to address the barriers hindering its implementation. By implementing appropriate strategies and fostering collaboration, blockchain technology have the capacity to serve as a powerful tool for enhancing the efficiency and sustainability of urban areas in India.

In this paper, the authors use bibliometric tools and methods to look at all the research on blockchain and smart cities that released between 2018 and 2023. We found some interesting trends in the way blockchain-based smart city research is growing, as well as the top countries and academic journals that are adding to this new field. The networks built by keyword co-occurrence and article citations helped us identify the main topics of the retrieved literature and the most important studies that expanded the field's conceptual understanding. For instance, blockchain technology used with the Internet of Things improves sensor data security and integrity in smart city systems. Combining blockchain and smart city technologies is promising for future study. IoT data can analysed using machine learning and saved and shared securely using blockchain technology. Due to their automation, smart contracts, enabled by blockchain technology,

used in many trade applications to share data, and ensure trust between service providers and network participants. Finally, blockchain found to enable smart communities and improve smart city sustainability.

8 Future scope of research

The research limited to the examination of blockchain's effects on the smart city fields, thus not addressing the entirety of its potential uses. This study encourages scholars to examine the challenges of blockchain technology in smart cities and urban initiatives in details. The findings of this research should spur additional research in this subject.

Future research might potentially prioritize the development of blockchain-based solutions that possess the ability to manage substantial volumes of data and transactions in a scalable and secure manner, while also ensuring privacy and interoperability. The proposed initiative holds significant potential for making a substantial impact on the domain of efficient and sustainable urban development in India. Furthermore, it is imperative to conduct research aimed at ascertaining strategies for mitigating the financial burden associated with the integration of blockchain technology into pre-existing systems and technologies within smart urban environments. Research may also prioritize the exploration of smart contract development, enabling the automation of interactions and transactions between parties. Additionally, it may investigate the integration of Internet of Things (IoT) devices to facilitate efficient data collecting and administration. Furthermore, research may aim to enhance data security and privacy in the context of smart city applications. Research can conduct to assess the utilization of blockchain technology in smart cities, examining its real-world applications, and identifying both potential challenges and chances for advancement.

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