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Blockchain as a Trust Builder in the Smart City Domain: A Systematic Literature Review

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ABSTRACT The revolution of the Internet of Things (IoT) is transforming many concepts, making them ''Smart''. It has revolutionized many areas of real life. Smart City is one of the key concepts of this revolution. Although cities are being digitally transformed, it still has obstacles along the way. In this paper, we have analyzed different publications for our Systematic Literature Review (SLR). This study highlights the areas where the blockchain is used and determines the benefits of using blockchain. The main contribution is to explore and identify the barriers and hurdles in Smart City Domain and how these hurdles are mitigated by the blockchain technology. This Systematic Study also addresses different challenges and issues such as security, immutability, interoperability, decentralization, privacy, and trust in the development of Smart Cities. An overview of the systematic research is also presented that would help identify the most and least studied concerns addressed in this study. This paper aims at analyzing how blockchain technology is used in different smart city business models, what are the features of blockchain that could consider it to be used beyond crypto currencies. We hope that this study can inspire interest in theory and exercise to stand-in discussions in this area adhere to these limits.

INDEX TERMS Blockchain, decentralization, the Internet of Things (IoT), smart city domain, systematic literature review (SLR).

I. INTRODUCTION

The concept of blockchain is almost 12 years old, with the introduction of cryptocurrency (Bitcoin) by Satoshi Nakamoto in 2008. Blockchain was initially proposed for the cryptocurrency. Bitcoin is considered to be instigated to offer a substitute to the monetary system, which many people reflect as the main cause of the economic crisis around 2008. By investigating the potential of blockchain, it has been recognized as the backbone for the areas where the term ''Smart'' is associated. It offers a decentralized approach, where no centralized source holds the control and data is never erased thus providing immutability. There have been amplified emphasis of reviewing the submission of blockchain in a comprehensive variety of applications, such as in solutions serving identity privacy and transaction safekeeping using a decentralized structure via diverse agreement methods (e.g. proof-of-work) amongst diverse geo-located IoT gadgets in our progressively digitalized culture e.g. Smart City [1]. Blockchain provides real-life implementations with a reliable, transparent, robust, and decentralized environment. Blockchain provides exceptional assistance which smart cities can leverage to expand the value of life, administrative processes, and environmental sustainability. Blockchain offers services like decentralization, security, privacy-preserving, immutability, and authenticity. The concept and necessity of Smart City have attracted a lot of attention because of its practical and realistic background. The recognition of Smart Cities is closely destined to the IoT viewpoint [2]. A Smart City practices information technology to assimilate and achieve bodily, social, and commercial setups to offer better services to its occupants while preserving well-organized and optimum exploitation of existing possessions [3]. A Systematic Literature Review (SLR) is presented in this paper following the guidelines of [4].

The main contributions of this study are

i) To identify the areas where blockchain is used.
ii) Identification of the barriers and hurdles in Smart City domain
iii) To focus on why blockchain technology should be implemented.

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The rest of the paper is well-organized as follows: Section. 2 delivers the contextual background of the blockchain and overview of the correlated work. Section 3 presents the contributions which enlighten the SLR process and in Section. 4 Conclusion and future research guidelines are discussed.

II. BACKGROUND

Blockchain is considered to be the second revolution after the internet. As the internet did for information, blockchain will do for the transactions. The use of blockchain for the domain of Smart Cities is quiet around but due to the lack of awareness, it has never been utilized in its true sense. Smart City covers a wide range of scenarios under its domain, such as education, mobility, home, energy, healthcare, industry, security, and privacy. Since many savvy frameworks have been actualized, security and protection issues have converted a significant test that requires compelling countermeasures. Be that as it may, customary digital security assurance methodologies cannot be applied legitimately to these keen applications by considering the dynamic qualities, heterogeneity, and adaptability of Smart Cities [5]. In a centralized approach, different domains of Smart City have different challenges. Current IoT frameworks depend on unified or expedited standards with gigantic computational and capacity limits. The current IoT arrangements are along these lines costly, inferable from the significant expenses caused by the cloud server setup(s) and maintenance. That is the reason blockchain becomes possibly the most important factor.

While the customer server worldview has been instrumental in interfacing conventional gadgets with one another for a considerable length of time, it will not have the option to help the difficulties that come from the development of the IoT economy. Utilizing a standard distributed decentralized correspondence approach will not just decrease the costs relating to the upkeep and foundation of server groups however will moreover share the planning and space necessities of a titanic number of contraptions on the IoT architecture, without sharing any additional resources. Blockchain offers a response that suits the necessity for such a phase. The greater part of the IoT gadgets have constrained assets, facilitating blockchain on IoT gadgets is a key test. Along these lines, numerous blockchain stages are building up a light customer, which will just keep the vital information on the gadget. Facilitating the blockchain straightforwardly on asset compelled IoT gadgets is not favored in light of the fact that IoT gadgets have Low computational assets.

A. PROBLEM STATEMENT

Internet of Things (IoT) devices have inadequate resources, compering blockchain on IoT devices is a vital challenge. There is no present stage that underpins correspondence between all gadgets, and an absence of confirmation that the facilities offered on the cloud by various manufacturers are interoperable. This paper aims to highlight the benefits of blockchain and uncover the hurdles that are prevailing in a smart city domain.

B. RESEARCH SCOPE

Bitcoin is the ultimate outcome of blockchain technology which is a type of cryptocurrency. This study aims to unveil the areas beyond cryptocurrency where blockchain can be beneficial. It studies numerous areas of a smart city and recognizes those areas where the blockchain revolution can be used to improve the cities for better living and commercial development. The scope of this research will cover the following points:

i) Review of existing Systematic Literature Review used for blockchain in the smart city domain.
ii) Analyzing and evaluating results with the proposed research questions.

III. RELATED WORK

There exist a few surveys, which consider the blockchain platform's security risks.

The heterogeneous nature of resource-constrained devices are highlighted by Biswas and Muthukkumarasamy [3], a Smart City is vulnerable to a number of security attacks. Another related study[1], overview the security attacks on the blockchain platforms & summarizes the security enhancements. Reference [2], demonstrated that current clouds cannot fulfill the new prerequisites of future adaptable IoT systems. They utilized blockchain's points of interest in a mix with haze figuring and Software-Defined Networking (SDN) innovation to build up a novel circulated engineering that fulfills the necessary structure standards, for example, versatility, productivity, flexibility, adaptability, and security. Further investigation by Brandão and Mamede [6], uncovers the developing enthusiasm for the topic of blockchain innovation.

IV. EXISTING SLRS OF BLOCKCHAIN IN SMART CITY DOMAIN

To grab the most relevant and updated information related to the blockchain for smart cities we applied different search strings to ensure the availability of Systematic Literature Review on the topic but it seems that there is very less work done specifically on the theme ''Blockchain for Smart Cities''.

The following strings were used to retrieve data from different sources

(Blockchain OR ''Blockchain for Smart Cities'') OR Review.

(OR ''Blockchain and Smart City'') AND SLR OR ''Systematic Literature Review''.

(''Blockchain for Smart City'' OR ''Using Blockchain for Smart Cities''.

(Smart City and Blockchain'' OR ''Smart City and research issues'').

(Blockchain OR ''Blockchain for the Smart City domain'') AND Review.

(OR ''Blockchain in Smart City'') AND SLR OR ''Systematic Literature Review''.

According to Brandão and Mamede [6], various articles focused on the areas: health (round about 5%), smart agreements, Smart Cities, and business (with about 10% each) digital forms of money, electronic government (about 12%), monetary (about 15%), IoT (about 30%), and bitcoin (about 40%), this point of view affirms the conventional model study information bolstered in blockchain innovation for keen spots, particularly when applied to Smart Cities.

According to Salha *et al.* [7], Smart City faces different difficulties. Probably the most critical difficulties are identified with the expanded measure of information move and guaranteeing security. This study presents the abilities to utilize innovative blockchain technology that can alleviate difficulties by capitalizing on the chances and advantages of blockchain and other new advancements. Blockchain development has giant potential for framing the upgraded Smart networks in the future in such manners that are increasingly proficient and give a superior nature of living.

Most of the existing studies cover the security and privacy concerns related to Smart Cities, whereas some addresses the benefits and challenges faced by smart cities. This study is unique concerning the current ones because it aims to answer three co-related research questions in a way that covers every aspect of the Smart City. The contributions are listed as follows.

- This study provides an extensive overview of Application areas of blockchain in Smart Cities from different perspectives and disciplines.
- This study evaluates the protection technologies for smart cities and presents some open issues.
- This study highlights the characteristics and benefits of using blockchain and identifies future research directions corresponding to the current challenges.

V. RESEARCH METHOD

To make available a translucent, reproducible, and systematic literature review of blockchain-based applications in the smart city domain, the guidelines of Kitchenham [4] have been incorporated. The operational tactic focuses to identify the need for the review and formulate a proposal for the review. Furthermore, to Identify the research, select the studies, assess the quality, extract data, synthesize the data, and finally report the results of the review.

Our research method comprises of the research questions Table 1, research objectives Table 2, data sources Table 3 used for retrieving papers, search strategy and study selection using the consideration and avoidance criteria Table 4 and Table 5 Data Extraction Description.

A. RESEARCH QUESTIONS

To identify the potential of blockchain, benefits, research issues, and challenges, Table 1 show the research questions for this study.

TABLE 1. Research question.

RQ ID	Research Question	Motivation
RQ 1	What are the application zones of blockchain Technology in the smart city domain?	The main aim is to highlight the areas of the smart city domain, where blockchain is being used.
RQ 2	What areas could be considered as a barrier for the Smart City and its domain?	The aim is to find out the hindrance involved in a Smart City domain.
RQ 3	What benefits blockchain brings to Smart Cities?	The objective is to uncover the benefits of blockchain technology

B. RESEARCH OBJECTIVES

This systematic review has been carried out for the objectives described in Table 2.

TABLE 2. Research objectives.

ID	Objectives
1	To study the areas explored by blockchain technology in the smart city domain.
2	i) To explore and identify the barriers and hurdles in the Smart City domain. ii) To identify the most and least studied concerns about Smart Cities.
3	To identify the characteristics of lifestyle by using the blockchain and to justify how blockchain technology could be the best-suited answer to the Smart Cities limitations.

C. DATA SOURCES

In this systematic review, different electronic databases TABLE 3 has been used as primary sources for blockchain in Smart City research publications. All of the sources returned results with some duplications but they were sorted and filtered to avoid duplication. The catalog Google Scholar of literature likewise permitted progressively speedy access to these and different databases.

TABLE 3. Data sources.

SOURCE	URL
IEEE Xplore	http://ieeexplore.ieee.org
ACM	http://portal.acm.org
Springer	http://www.springerlink.com
ScienceDirect	http://www.sciencedirect.com

D. SEARCH STRATEGY

The search strategy is conducted from 2008 to 2020. It is decided to start this Systematic Review Protocol from the

year 2008 because the first actual research in the blockchain was published in 2008. It was ensured that the search included conferences, symposiums, journals, magazines, workshops, and book sections. At first, we used a blend of watchwords including blockchain and city, yet found those chase terms too much confined. Blockchain application has been proposed on in many practical senses, a significant number of them contacting certain city parts however the papers do not state city or smart city explicitly. Consequently, we, in the end, settled discovering all papers on the strings, (''Blockchain for Smart City'' or ''Using Blockchain for Smart Cities'' or ''Smart City and research issues'').

TABLE 4. Inclusion/exclusion criteria.

Inclusion criteria	Exclusion criteria
Papers that may contain the terms Blockchain or Smart City or Both.	Duplicate or Repeated Publications
Peer-reviewed papers	The papers which are not available in the English language version.
Papers that describe all or some of the blockchain attributes.	The contents of the paper show that the study is concerned about a different subject from this work.

E. STUDY SELECTION

Thoroughly investigating the inclusion/exclusion criteria TABLE 4, the primary studies were selected. The primary focus was on the ''title'', ''abstract'' and ''conclusion'' of the papers to ensure the matching of the papers with our RQs. In some cases, titles and abstracts were not all-sufficient, therefore, full paper was investigated to make sure the compactness of inclusion and exclusion criteria. As a primary process of this Systematic Literature Review, 245 papers were retrieved from the electronic databases Figure 1, as shown in Figure 1. After the removal of (20) duplicate papers and applying inclusion and exclusion criteria and filtration, the number of papers was reduced to 33, which are selected as a primary study.

Figure 1 shows the primary study selection process.

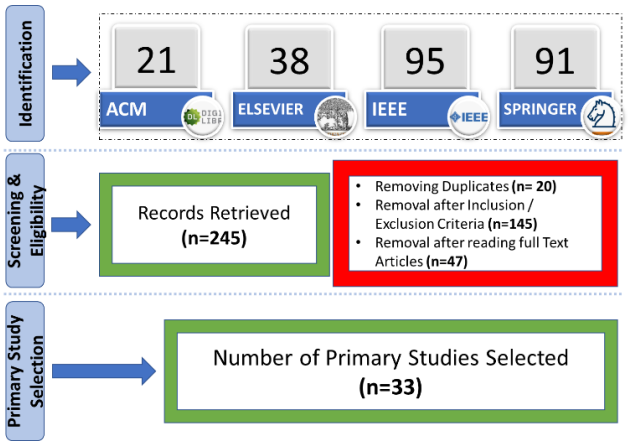

FIGURE 1. Study selection process.

F. DATA EXTRACTION

Different electronic databases TABLE 3 were searched for the data extraction process. Data were extracted by focusing on the objectives TABLE 2 and RQs to identify the potentials of blockchain, benefits, research issues, and challenges. Table 1 shows the research questions for this study.

Related information such as (Title, Author, paper title, paper reference type) was extracted to cover the objectives. TABLE 5 shows the information and data items that were utilized in each investigation including research questions and portrayals or descriptions related to our efficient systematic audit.

TABLE 5. Data item description.

Data item	Description	Study research Questions
Paper Title	Title name	RQ1
Author(s)	Study authors name	RQ1
Published in	(Journal / Conference)	RQ1
Name of Database	Name of the articles Database	RQ1
Year	The study/ research publication(s) period or duration.	RQ1
Research Type	Describes the type of research	RQ1, RQ2, RQ3
Research (Issues / Challenges) Identified	Describe the general characteristics proposed in each blockchain research issue.	RQ1, RQ2, RQ3
Design / Methodology / Approach	Research approach and framework	RQ1, RQ2
Future Work	The study's main conclusion and future directions.	RQ3

The first Research Question **(RQ1)** ''What are the application zones of blockchain Technology in the smart city domain?'', indicates the areas where blockchain technology is applied.

RQ2 ''What areas could be considered as a barrier for the Smart City and its domain?'', addresses the major concerns like design constraints, environmental data collection, and the lack of structures and procedures, etc.

RQ3 ''What benefits blockchain brings to Smart Cities?'', highlights the major benefits of blockchain e.g. secure communication without the involvement of mediation, permanent and immutable storage of information, etc.

VI. RESULTS AND DISCUSSIONS

This section provides detail and results of the research questions mentioned in TABLE 1. This section is further divided into 3 sub-sections (A, B, C). Section A identifies the areas where blockchain is being used. Section B highlights the barriers involved in the Smart City domain and section C uncovers the benefits of blockchain technology.

A. RQ1: WHAT ARE THE APPLICATION ZONES OF BLOCKCHAIN TECHNOLOGY IN THE SMART CITY DOMAIN?

The main aim of developing smart cities is to provide facilities to the residents to improve their living standards from different aspects, such as IoT, education, transportation, communication, construction, energy, healthcare, finance, and services, etc.

1) SMART COMMUNICATION

With the growth of technology, for example, the Internet of Things (IoT), distributed computing, and interconnected systems, smart urban communities can convey inventive arrangements and more straightforward communication and coordinated effort among residents and the local government [3]. Subsequently, the integration of smart devices with the blockchain has assisted with giving a protected communication platform in a smart city.

2) SMART TRANSPORTATION

The basic purpose of Smart transportation is to give a ''more intelligent'' utilization of transport frameworks. Specifically, astute vehicle systems can more readily serve the general population by improving security, speed, and dependability. With the quick development of urbanization, a smart city needs effective and supportable astute arrangements in transportation, environment vitality, government undertakings [1]. By utilizing transport-arranged mobile applications, consumers can without much of a stretch, plan their timetables while finding the most proficient and snappiest route. Other ordinary applications in smart vehicle networks are driver's universal IDs, license affirmation systems, vehicle - parking searching, and prediction [5].

3) SMART CONSTRUCTION

On the construction site blockchain can improve the unwavering quality and reliability of development [8]. It is concluded that blockchain provides a platform which is trustworthy and reliable for all sort of information management.

4) SMART COMMUNITIES

Third-party authentication is the main source by which the Centralized architecture relies upon to give security and assurance in the smart systems or networks, which may provoke a single reason for the fiasco and have other identified restrictions as well. [9]. To overcome the centralized architecture's limitations in a distributed system, blockchain provides a platform without involving a centralized authority.

5) SMART SERVICES

Smart services comprise of intelligent healthcare applications, smart services can make agreeable, shrewd, and vitality sparing living conditions, for example, through the remote control of home apparatuses. Interpersonal interaction, diversion, savvy shopping, and other keen administrations have impressively improved the comfort of individuals day by day lives[5].

Some of the blockchain-related applications for security and privacy are as follows;

Reference [8], describes the nature of blockchain in many ranges mostly where there is unnatural centralization and importance is mandatory for privacy. According to [10], Blockchain instruments to expand the security of a remote sensor framework without authority to devoted blockchain technology. Reference [11], describes that A vehicular system's physical asset, control, synchronization, and accumulation of a vehicular system are research challenges. Ferreira *et al.* [12], is of the view that the blockchain procedure aims at keeping away from costs (speculation and upkeep) and depends on a community-oriented way to deal with and recognize if parking spots are occupied, alongside gamification.

Blockchain technology is being applied in various other areas. **TABLE 6** shows the areas where blockchain is being applied for different purposes.

Generally, researchers were focusing more on the infrastructure rather than the use of this new technology for application purposes. Therefore, contents related to blockchain-based applications have been conspicuously published from 2016 onwards. It may also be the factor that a great number of scientific literatures has been published with a steady upward trend, in conference proceedings.

The graph in figure 2. shows the growing interest of researchers in blockchain technology in different application areas for the Smart City domain. The primary study shows that in 2016 it is 9%, which grew to 25% in 2017, in 2018 it grew even more to 28%, whereas in 2019 it shows the graph of 38%. It is evident from the fact that blockchain usage in different areas will grow over time.

B. RQ2: WHAT AREAS COULD BE CONSIDERED AS A BARRIER FOR THE SMART CITY AND ITS DOMAIN?

Although the previously mentioned advancements in smart cities have extensively shared to the upgrades of the entire society, pretty much every smart application is helpless against hacking through state-of-the-art assaults, for example, knowledge attacks, collusion assaults, Sybil assaults, spam assaults, agreeability assaults, inside inquisitive assaults, outside fabrication assaults, and identity assaults [5].

Based on the primary study the following factors are the main issues of Smart City operations.

TABLE 6. Application areas of blockchain in smart city domain.

S#	Application Area	Year	Reference
1.	Bitcoin and Cryptocurrency	2019	[13]
2.	Blockchain adoption in Higher Education	2019	[14]
3.	Persons with Disabilities	2019	[15]
4.	Governance of Smart Cities	2019	[16]
5.	Knowledge Governance	2019	[17]
6.	People-centric Smart Cities	2019	[18]
7.	Quality of life and businesses, resource deterioration	2019	[7]
8.	Blockchain in 5G Age	2019	[19]
9.	Smart City: Integrity and Reliability of the data.	2019	[20]
10.	Smart Communities	2019	[9], [13]
11.	Smart Environment and Smart Mobility	2019	[21]
12.	Smart Places	2018	[6]
13.	e-Government	2018	[22]
14.	Exchanging Data in Smart City	2018	[23]
15.	Health Care	2018	[24]
16.	IoT based Secure Smart City Architecture	2018	[25]
17.	Security and Resilience in Smart Cities	2018	[13]
18.	Smart City Infrastructure	2018	[26]
19.	Smart Surveillance	2018	[27]
20.	Wireless Communications	2018	[28]
21.	Construction Management	2017	[8]
22.	Industrial IoT	2017	[10]
23.	Lottery System for Smart Cities Applications	2017	[29]
24.	Online Business Processes.	2017	[30]
25.	Smart Cities Network architecture SDN	2017	[2]
26.	Smart City Digital Identity	2017	[31]
27.	Surveillance, assistance and energy saving	2017	[32]
28.	Vehicular Network Architecture	2017	[11]
29.	Smart Cities Security for the improvement of the Functionality of Urban systems.	2016	[5]
30.	Smart City from a sharing economy perspective.	2016	[33]
31.	Smart City: Secure Data Communication	2016	[3]

1) SECURITY, PRIVACY, AND FAIRNESS

Not very much endeavors have been made to give an in-depth investigation of the security and assurance properties of blockchain and unmistakable blockchain usage techniques. Design and business forms changing from various monetary foundations and the inclusion of manual procedures [13]. Because of the heterogeneous idea of resource-constrained devices, a smart city is weak against different security

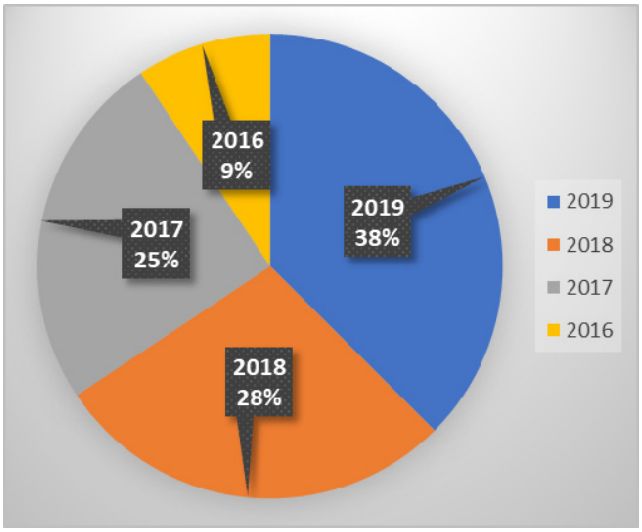

FIGURE 2. Blockchain application in smart city domain year-wise distribution.

ambushes. Threat on availability, threat on integrity, threat on confidentiality, threat on authenticity, threat on accountability [3]. A portion of the issues is classification, provenance tracking, disintermediation, non-renouncement, multiparty conglomeration, detectability between hierarchical record-keeping, information possession, and so on [8]. Security and protection are significant issues [30]. A vehicular system's physical resources, control, synchronization, and collection of a vehicular system are the challenges [11]. Currently, available lottery games rely upon a brought together black box of administrations and exercises, which causes questions or doubts on players or citizens in various points [29]. Evaluating and overseeing trust with hard-to-produce scientific calculations. Proficient sending of edge nodes and empowering of caching strategy at the edge node [11]. Security and flexibility in smart cities are potential security concerns [13]. Securing the data transactions such as student profiles and certifications is of significant concern for security professions [14]. The incorporation of healthcare and smart cities has exposed the healthcare industry to security encounters [24]. Digital disruption presents numerous provokes identified with data security and protection [3].

2) IDENTITY PRIVACY, TRANSACTION SECURITY AND ANONYMITY

In the blockchain network, node failure can occur, for instance, because of equipment failure or egotistical nodes. Every node in a blockchain needs to perform a comparable task for the confirmation of every transaction simultaneously; thus, bringing about a high calculation cost. Obscurity and security spillage are two other progressing issues [1]. Untrustworthy communication because of remote transmission; Security; design constraints need for self-configuration and adaptation to internal failure [10].

TABLE 7. Benefits of blockchain.

Source	Benefits with respect to the nature of the application field
[13]	The cutting-edge economic industry will highly benefit from the Blockchain along with artificial intelligence and big data.
[3]	Secure communication of the devices in a distributed architecture.
[8]	Blockchain can address a couple of issues that unsettle the business to use Business information modelings, such as multiparty accumulation and confidentiality.
[1]	Blockchain can be utilized to accomplish properties that may be lacking in a centralized system in a smart community setting. Such as confidentiality and non-repudiation.
[30]	One of the most alluring highlights of the blockchain innovation is its security system dependent on an open ledger and distributed agreement.
[11]	An architecture grounded on blockchain in the smart city for the vehicle system will permit the advancement of the dispersed system of large-scale vehicles in an increasingly proficient and viable manner. Blockchain provides security and privacy and avoids tampering of information by attackers.
[22]	Blockchain innovation is a significant achievement with incredible potential in open divisions. It can make government activities progressively effective by improving the conveyance of open administrations and expanding trust in open parts.
[29]	The emerging blockchain technology shows a look at answers for decency and transparency issues faced by lottery industries.
Source	**Benefits with respect to the nature of the application field**
[15]	Blockchain gives the likelihood that each PWD gets, as indicated by their social-monetary profile, the base conditions required for educational achievement.
[3]	All gadgets would have the option to impart safely in a disseminated domain.
[23]	Blockchain understands the protected sharing of information and addresses the issue of smart city construction.
[21]	Blockchain permits the usage of advanced methodologies that are individuals focused and lead to high technology-based innovations to create more limits and openings
[17]	Blockchain sorts out the smart services and advances knowledge development and competitiveness and stimulating smart solutions.
[12]	The Blockchain procedure in this study aims at maintaining a strategic distance from costs (venture and upkeep) and depends on a community-oriented way to recognize if parking spots are occupied, alongside a gamification motivation.

3) DATA PRIVACY, SCALABILITY, AND INTEROPERABILITY

In the present smart city network design, different Issues, for example, high latency, bandwidth blockages, security and protection, and adaptability may emerge [11]. To guarantee anonymity and limit privacy spillage are two on-going issues [1].

4) SURVEILLANCE AND ASSISTANCE

Surveillance, assistance, and the utilization of suitable technology for energy saving and to lessen the ecological effect [32]. Systems shortcoming to a sudden one point failure and security break owning to the nonattendance of assurance [27].

5) TRANSPARENCY, DATA INTEGRITY, AND FRAUD PREVENTION

The appropriation of new technology to improve open assistance has become progressively critical for government associations [22]. Data should be shielded from any adjustment all through their lifecycle. This causes some exceptional difficulties, such as information practicality, Unreliable data, Malicious activities, and Data quality [18].

6) BANDWIDTH AND DELAY

Considering the bandwidth and delay properties, wireless communications causes significant problems due to Massive development in the mobile transmission traffic [28].

7) STRUCTURE AND ARCHITECTURE

How to recognize that blockchain can be actualized in smart cities to help the incorporation of PWD? Criteria to evaluate a city's inclusiveness, architectonical barriers, the lack of structures and procedures are the main issues [15].

8) VULNERABILITY AND LESS RESOURCE AVAILABILITY

Standard security protocols are heavyweight in terms of memory footprints which make all the security protocol unfit for budgeted platforms such as the Internet of Things (IoT) [25].

9) IDENTITY AND AUTHENTICATION

In the near future, It is vigorous to confirm the authentication of citizens for a great deal of cutting edge services [31].

It has been observed from the literature that most of the application fields suffer from Privacy and Security concerns. The use of digital currency is still in the evolving stage and faces many unsettled glitches such as verification processes, transaction costs, data limits, etc. To overcome such problems, it needs constant developments. The improvement of public service delivery is becoming a challenge for government organizations. Protection of data to a certain level is not sufficient it needs to be protected throughout their lifecycle. Data quality, modifiable data, and malicious activities are some other unique issues that disrupt the Smart City activities. On the other hand, the increasing growth

in mobile transmission traffic, wireless communications are causing serious problems like bandwidth and delay.

C. RQ3: WHAT BENEFITS BLOCKCHAIN BRINGS TO SMART CITIES AND ITS DOMAIN?

Blockchain can have several benefits, some of which are explained as follows.

1) ***DECENTRALIZATION:*** The specialty of blockchain is its decentralized nature. There is no focal authority or the single party associated with its creation. It is the consortium of computer networks that makes the chain. Blockchain has minimal hack threats because of the regular up-gradation and security of the network for which they get rewards.
2) ***NO THIRD PARTY/INTERMEDIARY:*** Blockchain works without the participation of the third party. Sell and buy between two parties takes place without any interference from any monetary organization.
3) ***LOW COST, FAST TRANSACTIONS:*** Online activities happen faster. The amount can be transferred in seconds. Transaction costs are low due to the absence of third-party involvement.
4) ***POWER TO USERS:*** People have better admittance and control. For example, digital wallets are easy to set up, they can be set up in no time on a computer at an individual's comfort zone.
5) ***RELIABLE DATABASE:*** Database is created without disclosing name and identity in a timely, sequential, and chronological way. It works on the concept of digital id to inform about the transaction history.
6) ***TRANSPARENCY:*** All parties can view a blockchain, all transactions are created in an open log and are perpetual, the system makes more transparency and durability.
7) ***IMMUTABILITY:*** It refers to the logs of transactions, which remains unchanged or can never be deleted.

TABLE 7 shows the benefits highlighted by the researchers.

The data shows significant importance of the integration of blockchain technology in different sectors, regardless of whether it is transportation, healthcare, communication, energy, banking, or government ventures. Some major companies like Microsoft, IBM are developing cloud-based blockchain services. Due to the qualities of disintermediation, reliability and durability factors businesses can benefit from this technology. Blockchain presents security, extensibility, and creditability in the realization of a smart city.

VII. CONCLUSION

This Systematic Literature Review on the blockchain for the Smart City domain explores the limitations of centralized architecture. How blockchain implementation could change the living standard of people? What security risks or hurdles are present and what security risks are mitigated by introducing the blockchain to the Smart Cities? Considering the qualities, a blockchain foundation in a smart city will improve sharing of information, and updates will happen seamlessly and securely. Even though blockchain would limit cost and time transaction process, at first it will require a great deal of resources. It also consumes a lot of power as the transactions are validated constantly. Blockchain can bring about a more accountable way of citizens participating in governance. It is concluded that blockchain provides a platform which is trustworthy and reliable for all sort of information management. The technology is yet to be acquainted with common masses, particularly in developing nations. Individuals are acquainted with age-old frameworks. It would require some investment to move their concentration towards a progressively decentralized, online framework. Additionally, numerous legislatures need to authorize them in public transactions. The decentralization idea is generally new however advancing quickly hence not covering all conceivable security risks. Therefore, here is a strong possibility of a wide range of security issues ahead. There is a need for the entirety of blockchain in one function (scalability) for Smart Cities to make them smarter.

VIII. FUTURE DIRECTIONS

Although blockchain innovation guarantees secure or private transactions, there is as yet a requirement for solid encryption techniques. Limited supremacy of computation is being identified in many IoT devices and other sensors which forces them to use only simple cryptography algorithms therefore encryption, biometrics, anonymity are unfortunately not enough for the smart city architecture. There is a need for blockchain to be integrated with the media sector that can help the media business in making sure about protected rights. Blockchain can assist innovative communities with authenticating and attribute the source. There is still a need for improvements in the health sector to ensure the security and integrity of records. The travel sector can be benefited from this technology for the better management of traveler's data. The government sector can utilize blockchain for proficiently keeping up open records. This will ensure transparency in investments and purchases and will bring authenticity hence minimizing corruption in the government sector. Energy Sectors can use this technology for smart meters. Smart meters and smart money will assist individuals to deal with their bills proficiently. Regulatory System is also a vital issue facing ahead. The monetary system must be controlled by the government to tackle the misuse of bitcoin in funding it in criminal activities or transferring black money. It is expected that this paper will animate enthusiasm for additional conversations and research in these zones.

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