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A review on smart building and blockchain technology

Akıllı bina ve blokzincir teknolojisi üzerine bir inceleme

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A Review on Smart Building and Blockchain Technology

Akıllı Bina ve Blokzincir Teknolojisi Üzerine Bir İnceleme

Highlights

- *Literature review about keyword*
- *Studies covering both were compiled*
- *Literature on payments, supply chain and energy were collected*

Graphical Abstract

The literature on the use of blockchain technology in smart buildings has been examined, and the studies are examined under three main subheadings: smart buildings, blockchain technology and joint studies containing both keywords.

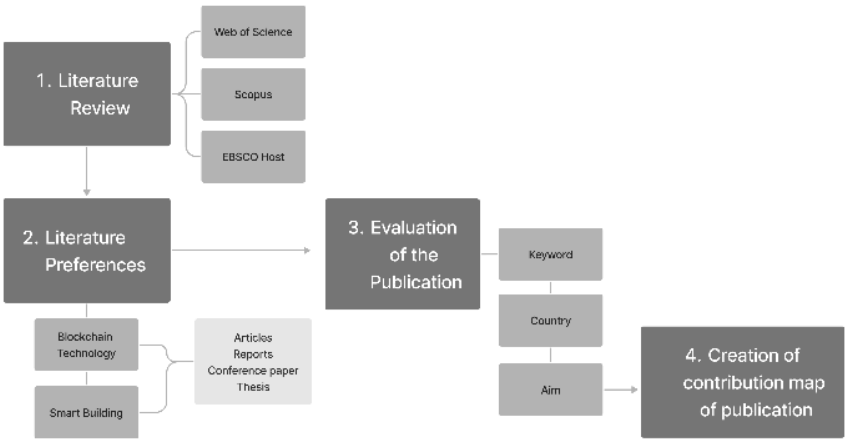

Figure. Study Steps Literature Review

Aim

Keywords examined to discuss what can be used to process data in smart buildings and ensure the security of this data.

Design & Methodology

Studies published on the keywords "Smart Building" and "Blockchain Technology" between 2007 and 2022 was examined.

Originality

It is a collection of studies on the topics of smart buildings and blockchain technology.

Findings

It is noteworthy that a cluster of 12 articles, among the total of 121 publications reviewed, intersect both blockchain technology and smart buildings.

Conclusion

Examining integrating of blockchain into smart building systems, specifically within the domain of energy management, could enhance operational effectiveness.

Declaration of Ethical Standards

The author(s) of this article declare that the materials and methods used in this study do not require ethical committee permission and/or legal-special permission.

A Review on Smart Building and Blockchain Technology

Review Article

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ABSTRACT

A review of the historical development of humanity reveals a pattern of continuous change and growth, driven by the emergence of new needs and the creation of solutions to meet these requirements. One such development is the Industrial Revolution, which brought about a transformation in consumption patterns and the limits of what could be consumed. This revolution also brought about the significance of energy production and consumption. Given that the construction industry is the field that consumes the most energy, it is of paramount importance to control energy in buildings. In light of this, it is evident that smart building systems, which require sensor data and an internet connection, have emerged as a necessity. Consequently, a new requirement has emerged regarding the security and storage of sensor data. Blockchain technology is considered a feasible option to address uncertainties related to process tracking, data storage and data transparency. Based on this problem, the studies that have been done so far have been examined using the systematic literature review method using the specified keywords which divided into subheadings. This paper discusses the keywords "blockchain technology" and "smart building" in the literature to discuss the processing of data in smart buildings and the security of this data.

Keywords: “blockchain technology”, “energy”, “smart building”

Akıllı Bina ve Blokzincir Teknolojisi Üzerine Bir İnceleme

ÖZ

İnsanlığın tarihsel gelişimi incelendiğinde, yeni ihtiyaçların ortaya çıkması ve bu ihtiyaçları karşılayacak çözümlerin yaratılmasıyla sürekli bir değişim ve büyüme modeli ortaya çıkmaktadır. Bu gelişmelerden biri de tüketim kalıplarında ve tüketilebilecek şeylerin sınırlarında bir dönüşüme yol açan Sanayi Devrimi'dir. Bu devrim aynı zamanda enerji üretimi ve tüketiminin önemini de beraberinde getirmiştir. İnşaat sektörünün en çok enerji tüketen alan olduğu düşünüldüğünde, binalarda enerjinin kontrol altına alınması büyük önem taşımaktadır. Bunun ışığında, sensör verilerine ve internet bağlantısına ihtiyaç duyan akıllı bina sistemlerinin bir gereklilik olarak ortaya çıktığı açıktır. Dolayısıyla, sensör verilerinin güvenliği ve depolanmasına ilişkin yeni bir gereksinim ortaya çıkmıştır. Blockchain teknolojisi, süreç takibi, veri depolama ve veri şeffaflığı ile ilgili belirsizliklerin giderilmesi için uygulanabilir bir seçenek olarak değerlendirilmektedir. Bu sorundan yola çıkarak, bugüne kadar yapılmış olan çalışmalar, belirlenen anahtar kelimeler kullanılarak sistematik literatür taraması yöntemi ile incelenmiştir. Anahtar kelimeler ayrıca kendi alt başlıklarına göre ayrılmış ve incelenmiştir. Bu bildiride, akıllı binalardaki verilerin işlenmesi ve bu verilerin güvenliğini tartışmak için literatürdeki "blockchain teknolojisi" ve "akıllı bina" anahtar kelimeleri ele alınmaktadır.

Anahtar Kelimeler: “blokzincir teknolojisi”, “enerji”, “akıllı binalar”

1. INTRODUCTION

Humanity has continued evolution and progress since the beginning of the universe. While this development and changes are compulsory after a link of the chain. When looking at the reasons facing humanitarian requirements which have triggered each other’s. This relation always affected human life both better and worse. Life was supposed to be easier, but the world also had to overcome the side effects. The Industrial Revolution was the most crucial example of the last two centuries. After the Industrial Revolution cheap worker requirements were increased in the cities, people in the rural areas were moved from their villages and thereby the city population was increased, and cheap and fast real estate property requirements existed. The last statistics show that above 50% of the total world

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population lives in the cities [1]. Suchlike, there are lots of problems and solutions for humanity. Another one is global warming triggered by climate change emerging problems that started with melting glaciers. This affected agricultural land area and efficiencies thereby food supply chain problems. Air, water, and ground pollution are the other side of these domino stones [2], [3].

Essentially, in the last half-century, another crucial problem called "Energy" has emerged that has its origins in the Industrial Revolution. After this date, machinery fabrication is on the rise and emerged fuel meaning energy that is required for the devices to work. This energy definition evolved everywhere and each step required energy. According to the statistics, the construction sector has a crucial effect on energy usage which means 30% of global energy consumption. Another important data is that more than 50% of the world's electricity consumption is consumed by the construction sector. About the Carbon, One-third of the Carbon emission is also the construction sector. All these consumptions triggered water consumption. 25% of water consumption was from the construction sector meaning buildings [4]. Consumption of water, electricity, other energy types, and carbon emissions are mostly produced by the construction sector and affect the whole world.

Each innovation has revealed other needs and affected humanity's future. These have survived to the present day with the effect of dominoes and one of the most crucial has been the Industrial Revolution raw material searching. The energy has also become a major raw material. Obtaining energy and managing it correctly has been an important goal. The starting of this goal evolved into bigger concepts and movements. Such as sustainability and renewability have started to be discussed [5]. The word sustainability was fully defined and used at a conference, but in the long run, it is known, and its rules apply to humanity. Maintaining something itself is crucial in this century. Every device and system need inputs and outputs; however, limitations have to be discussed. These all-negative scenarios pushed some worries and controlling concepts and technologies were developed. As a result of these worries, namely digitalization, unmanned systems have been used in most areas. One of these is also the construction sector. The sensor data which is taken from automatic sensors can be handled by some calculations or devices. Many processes in the building are transferred to the system with the help of sensor data. Depending on the authority of the system, the automatic or semi-automatic decision mechanism comes into play. The buildings where this technology is applied are also called smart buildings. In other words, smart buildings can be called an integrated version of technology in buildings. Although smart building systems have several advantages, at the same time some problems also emerged over time regarding the operation of the system and data storage [6].

In recent years, the perspective on data and data storage has shifted. Common cloud systems are no longer adequate in terms of storage capacity and security. In contrast, Blockchain technology emerged during this period and offers a new, transparent and secure option in this field. The first ideas and definitions for Blockchain technology (BTC) arose in the 1990s by a group of researchers. However, the first concrete definition comes from Satoshi Nakamoto in 2008 [7].

It has been accepted by all sectors that architecture is not only a field where physical designs are made through 2D or 3D programmes, but also a field where the constructed structure should work in an integrated manner with all areas and act as a conductor for them. If we consider the construction sector, there is a very long process that will go from the architect's negotiations with the employer, building supervision during the construction phase, construction site supervision, and delivery to the employer. It is of great importance to manage all these in a smart coordinated manner. With the new technologies that dominate today, the methods used are also revised. Based on this acceptance, the integration of new developing technologies into the architecture sector will be inevitable. [8] mention that a mandatory prerequisite for the application of Blockchain Technology in the architecture sector is the high degree of digitization of information, digital processes and a reliable digital infrastructure. With the inevitability of digital evolution in the AEC industry, it is predicted that blockchain technology will be integrated into the architecture sector.

Consumption is increasing in various sectors due to technological advancements, including construction. It is essential for humanity to regulate consumption to ensure sustainability. The aforementioned reasons can be implemented using blockchain technology principles and existing reasons for smart buildings. The examined keywords are mutually supportive. Furthermore, in light of the evolving technological landscape, the architectural sector must also embrace innovation in order to remain relevant. This study analyses the keywords "blockchain technology " and "smart building " found in the literature, in order to discuss their potential in processing data and ensuring security in smart buildings. This paper aims to investigate how smart buildings can operate using blockchain technology, and will discuss the lifespan of building elements and their integration into the energy cycle.

2. METHODOLOGY: OVERVIEW OF BLOCKCHAIN TECHNOLOGY AND SMART BUILDING

When analysing literature on the use of Blockchain Technology in Smart Buildings, studies are reviewed based on three main subheadings: smart buildings, blockchain technology, and joint studies involving both keywords. The majority of studies under the

subheading of smart buildings focus on energy management. Within the examined studies, several methods have been proposed for data and energy control in smart buildings. The focus of the methods employed primarily centres on cloud systems. Within the literature, the most frequent subheadings under the heading of smart buildings are remote control systems and IoT. In the studies analysed under the key category of Blockchain Technology, the payment and financial subheadings stood out. Additional subheadings were health and supply chai

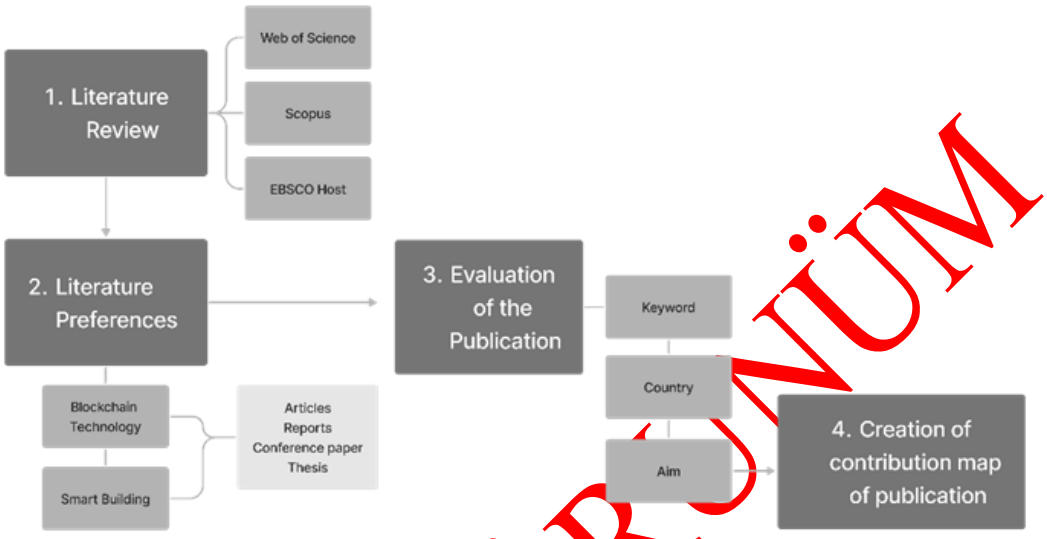

Figure 1. Study steps Literature review

Systematic analyses were conducted using research databases such as "Web of Science," "Scopus," and "EBSCOhost" to ensure adequate article coverage. The rationale for selecting these three research databases is based on the quality of their publications, which provide comprehensive coverage of high-impact, multidisciplinary research and studies conducted globally. Articles published between 2007 and 2022 were analysed to comprehensively understand the innovative features and importance of the project. The methodology section is organised as follows: Section I provides a literature review of Blockchain Technology, Section II discusses literature related to Smart Buildings, and Section III presents collaborative work on Blockchain Technology and Smart Buildings.

2.1. Blockchain Technology

The literature has been reviewed and identified nine primary topics pertaining to Blockchain Technology. The majority of the studies collected were related to payment and finance or supply chain, with the least number of studies focusing on smart grid, education and agriculture. When examining the studies, the majority of them are review articles that have been published in academic journals. In this section, a detailed literature review has been presented. While there are numerous previous studies on blockchain technology, what sets this study apart is its critical examination of blockchain technology and its applicability to smart building systems from an architectural perspective.

Several prominent studies have explored blockchain technology, with definitions widely available in the literature. [9] presents computer systems and cryptographic techniques that are widely trusted. The paper also highlights the advantages and includes multiple vault presentations. [10] aim to assess the benefits and drawbacks of incorporating blockchain technology across multiple sectors. The authors explore possible challenges and conveniences of blockchain integration. Key advantages include efficient record-keeping, heightened data security, increased trust, immutability, transparency, and fast processing. High energy consumption, the requirement to use the same forks or software, high costs, and the need for quantitative balance between nodes are drawbacks. [11] provides an overview of the historical background, architecture, manner of work, pros, and cons of blockchain technology in various sectors. The article explores the potential applications of this technology while maintaining objectivity and avoiding biased language. The text is structured with clear progression and causal connections between statements, using simple and concise sentences with precise vocabulary. The author adheres to conventional academic structure, maintaining consistent formatting and style guides, including clear citations and avoiding filler words. The language is formal with no use of contractions, colloquialisms, or unnecessary jargon. The author

explains technical abbreviations when first used and aims for grammatical correctness throughout the text. [12] provide an outlook for identifying blockchain algorithms, architecture and security aspects. Analyze comparative framework and this paper discusses in detail future direction and novel using field and research challenges. [13] provide detailed information on the technology's features, structures, mining decisions, forks, and applications. Their goal is to offer technical insight. [14] conducted a comprehensive survey study on blockchain, which outlines blockchain terms, its history, consensus algorithms, cryptography, and smart contracts. The study also provides in-depth information on various security analysis methods.

When investigating the applications of blockchain technology in the payment and finance fields, it is important to note that its inception began with [15] definition of the first electronic peer-to-peer payment system and the introduction of novel keywords such as proof-of-work chain, peer-to-peer, and timestamps for transactions. This paper conducts a comprehensive study in financial and payment contexts and proposes a computational proof solution for maintaining chronological order of transactions. [16] presented a private smart contract system with a decentralized and defined security protocol in the HAWK program. The paper presents formal blockchain model's theoretical results as well. [17] The main principle of blockchain technology in the financial sector is discussed without detail. Cryptocurrency, bitcoin, coins, tokens, and payment keywords are frequently used. Additionally, Vitalik Butern's definition is discussed, and examples of blockchain technology applications are given. [18] a need for new research on the implications and the potentials of blockchain technology is also discussed without biased language. [19] analyses the financial and payment-related challenges and regulatory impacts on the implementation of blockchain technology in the US and EU. Additionally, the paper discusses the practices and views of governments on this issue. [20] discuss the components of blockchain technology and their provisions. Presented is a high-level categorisation of private and permissioned blockchain, which includes the definition of architecture, hashes, ledger, and blocks of blockchain. [21] discusses the implementation of blockchain technology in e-government, specifically in China. The government has attempted to systematize and informatize security, construction, and guaranteed credit. This project aims to solve the problem of individuals' credit by disclosing reliable information about their livelihoods. The advantages of this project align with the national informatization strategy for trade. [22] looking chalenges and opportunities of application of blockchain technology under the banking or finance field and also paper tried to calculate the total energy consumption of bitcoin. [23] definition journal. In general, it identified blockchain technology, cryptocurrency, distributed ledger technology (DLT), smart contract, BC basis .... [24] created a literature review for the future study and its acceptance about finance, marketplace in the blockchain technology. [25] discuss the blockchain technology in the IT understanding and give some general information about these keywords. [26] summarise the literature application of BC and DLT in the different cryptocurrencies and payment options. [27] mention about the crucial impact of blockchain technology and the general way of our life. The paper aims to show the potential in smart contracts, smart cities, digital identity, electronic medical records and IoT. [28] aim to provide a guide about blockchain for a community and individuals. What kind of blockchain, why and how can be used and all this information can be accessed from this paper. The terminology starts with Distributed Legendre Technology (DLT) and goes to the blockchain technology. It also gives information about the main blockchain platforms. This paper contains comprehensive information about blockchain technology, especially in the financial sector. [29] aim to give an overview of working blockchain technology, its types, and its platforms. And also gives some information about the working procedure of blockchain platforms. [30] discuss the impact of the blockchain audit industry and finance sector. [31] analysis of blockchain technology and its advantages and disadvantages and also types in the process of using cryptocurrency. [32] bring clarity fashion of energy consumption of Bitcoin and look beyond these myths. Analyzing the literature review about the energy consumption of bitcoin and alternatives, and observe the close interrelationship between security and choice consensus mechanism and its characteristic, thus energy consumption. In summary, the energy consumption of blockchain technology varies significantly between different types. [33] analyse the public key infrastructure and management for the Bitcoin wallet, and discuss the use of IoT systems in blockchain technology systems. [34] describe blockchain technology and give examples from both financial and non-financial sectors. It also described the risk of adoptions and corporations. [35] present a systematic mapping by collecting all relevant research about blockchain technology. Results show that 80% focus Bitcoin and 20% deal with other fields of blockchain technology.

The studies concerning the use of blockchain in the energy sector, specifically the monitoring of energy production and management, are presented below: [36] presented idea of renewable energy generation sources management system with blockchain technology. [37] mentions about energy certification systems and enabling a blockchain system energy efficiency, storage data and trust between stakeholders. [38] provides a proves of blockchain technology fundaments and system structures within the energy sector. [32] bringing clarity fashion of energy consumption of bitcoin and looking beyond of these myths. Analyzed literature review about energy consumption of bitcoin and alternatives, and observe

that close interrelationship between security and choice consensus mechanism and its characteristic, thus energy consumption. To sum up, energy consumption of blockchain technology varies importantly between different types. [39] discuss using blockchain concept in energy management with the circular economy. The aim of the study that shows the contribution of blockchain to a circular economy for energy management. And also, discuss the advantages and disadvantages of these keywords.

The second area where blockchain technology is most applied is supply chain. The studies done on this subject are as follows. [40] conducted a literature review on combating the duplication of permissioned blockchain technology in the supply chain industry. They also analysed the role of BNC, a brand name company, in this combat. [41] aim to present a conceptual framework for integrating blockchain technology to establish a sustainable supply chain system, using the Spherical Fuzzy Analytic Hierarchy Process (SF-AHP) approach. [42] present a review of trends in blockchain technology using logistics and supply chain fields. Inform about blockchain using types and define that "register, confirm and transfer any kind of contract and property". Also, the authors talk about blockchain possibilities for BC usage, so they compare with traditional process vs blockchain system. Gives some examples about the logistics sector and conclusion BC has huge potential in the supply chain meaning logistics sector. [43] encourage blockchain studies in supply chain management and define potential areas of implementation. In the conclusion section, the lack of literature in the field of operations and supply chain management is identified. A literature review on the supply chain management within blockchain technology exists [44]. The review evaluated potential and trends in this area and found that blockchain technology is growing rapidly in various industries, indicating vast potential in supply chain management. [45] this article discusses the risks and uncertainties associated with blockchain technology in the supply chain field. It explores concepts such as cryptocurrency, blockchain architecture, as well as supply chain management and its resilience. [46] the paper further examines the potential applications of blockchain technology in the supply chain field. It identifies four barriers hindering the adoption of the technology and narrows down to the most practical application. [47] additionally, the study defines various cyber threats to the blockchain system and how it will react to such situations. In conclusion part, BC has several ways of protect data and process, however Intrusion Detection System IDS should improve.

Another potential area for the application of blockchain technology within the agricultural sector is in research studies. This field offers the opportunity to enhance the transparency and trustworthiness of the supply chain, whilst also improving accountability, traceability, and sustainability. Through the use of blockchain technology, it can be possible to track and document each stage in the supply chain, from the farm to the table, thus guaranteeing the safety and quality of the food produced. [48], this survey provides a technical and application overview of blockchain technology in the agriculture field. It identifies the data structure, cryptography methods, and consensus mechanisms, categorizes applications through literature reviews, and discusses challenges and potentials. Furthermore, the survey examines how e-agriculture systems could impact the entire sector and play a critical role in addressing the food crisis in the farming industry. [49] investigated the implementation of blockchain technology in agricultural product supply chains, smart farming, and insurance protocols from both a theoretical and practical perspective. In summary, the use of blockchain can enhance food supply chain management and data-driven procedures. Nonetheless, challenges include the motivation of transaction parties and indirect integration with legacy systems.

There have been studies on education, including [50] which provides fundamental knowledge on blockchain technology and its benefits for education. It highlights that the evaluation process is a problematic issue. In addition, [51] critically analyzes the application of blockchain technology's potentials and challenges in higher education.

Studies on the integration of the construction industry, which is the primary objective of this paper, are summarised. [52] provided literature on the potential usefulness of blockchain technology in the construction sector. One prominent application is the blockchain 2.0 "smart contract" which provides insurance contracts. Technical term abbreviations are fully explained when first used. Quotes are clearly marked, and filler words are avoided. Another application is the management and recording of all changes in BIM models throughout the design and construction stages. Formatting adheres to established style guides and citation practices. [53] the investigation of potential blockchain technology applications in the construction sector reveals that trustworthy supply chain and asset management pose main challenges in this field. Blockchain technology with transparency, immutability, and smart contract principles offers a solution. However, three challenges exist, including technological, construction business-related, and human-related challenges. The author proposes that the combination of BIM and blockchain technology could create a crucial, transparent, and enduring chain. [54] discusses the prevalent issues in the construction industry and how blockchain technology, alongside its historical developments, might help to address these difficulties.

The following section outlines the focus of this investigation, which is centred on smart grid and smart building studies. [55] examined how emerging blockchain can aid in the development of smart grids. The investigation employs an evaluation of the human, technological, and organisational aspects of this triangle. From an economic standpoint, blockchain technology can play a vital role in the development of

smart cities. [56] discuss the security aspect of blockchain in smart cities and smart devices. There are numerous advantages in countering threats and yielding benefits such as dependable, swift, and efficient operational management, as well as scalability.

The literature about the health sector is vast and diverse. This paper aims to provide an objective overview of current research in this sector, focusing on key areas such as healthcare systems, disease prevention, and public health policy. [57] aim to show that there are numerous starting points for using blockchain technology in the healthcare sector and also the potentials, goals, and possible impact of blockchain technology in the healthcare sector. The most important aim is fighting counterfeit drugs. [58] discussing the potential impact of blockchain technology in the health field. Privacy and data sharing is the main problem. [59] discuss the "HealthChain" keyword which is a cloud-based application. Describe why blockchain technology should or could be used in the healthcare sector. A person, doctor, insurance company, etc. can observe related things. [60] study blockchain potentials and implementation areas in the health sector, drug supply chain, medicine education, electronic health records, and public health issues. [61] focused on the implementation of blockchain technology healthcare sector for defining potentials and investigating case studies. This paper also examines interoperability criteria. [62] discuss the potential of blockchain in the healthcare industry today and future applications. Mentioned some survey healthcare applications and results showed that storing all health records in a blockchain, interpreted some potential security barrier for implementations. [63] reported a systematic review of using blockchain technology in the healthcare sector. *"The research methodology is based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines and a systematic mapping study process ..."*. There are some limitations and challenges for blockchain-based healthcare. [64] presented options for using blockchain technology potentials and challenges in the healthcare sector. [65] studied the important benefits of blockchain technology in the healthcare field and defined fourteen implementations. Using clinical trials, record keeping, improving safety, monitoring patients, displaying information and transparency. Keeping records and monitoring is provided that they require data from third parties. [66] a defined gap of blockchain technology in the healthcare industry and its potential E-health systems. [67] provided a literature review about the important role of blockchain technology in the healthcare field with COVID-19. Also, this paper discusses challenges and opportunities in the application examples (collect data with wearable technologies. Fe. Apple, Google, Amazon Watch, and other vehicle applications).

The law and legality surrounding blockchain technology are of great importance. Several studies have been conducted on this topic. [68] discuss from the legal perspective of the blockchain technology. This paper provides different discourses of alegality. To sum up, there is a lack of law in the blockchain technology so this situation is called "alegality". This is true actions are not illegal because there isn't any law or regulator in this field but some actions are not described as legal. Also, this article is funded by the European Research Council under the European Union's Horizon 2020. [69] aim to fill the literature gap and examine such proposals for governmental issues about the blockchain technology. In conclusion, if governments are decentralized, permissioned blockchains probably be more available.

Finally, the studies examined under the heading of IoT are as follows. [70] detected the aspects that need improvement in the architecture of blockchain and IoT systems. The paper also suggested enhancing the efficiency of the integration of BC and IoT. [71] combine systematic literature review and bibliometric analysis for defining blockchain adoption and its technological development. Web of Science and Scopus databases were used and the date limitation was started in 2015 and the region contains Malaysia. Technology acceptance models are defined in detail and 5 best known theories were used to organize this study. [72] discussing difficulties of security and privacy of data problems in IoT. These papers also mention the main sources of these problems and the solutions. [73]tried to create a comprehensive survey on the blockchain technology and its architecture, potential, and challenges. BC uses lots of fields but privacy and security are controversial topics.

Table 1. A brief summary of literature review about blockchain technology

Field	Author	Type	General	Review	Scope
Payment Finance	[28]	Journal		✓	Created an extensive guideline about blockchain technology; answered when, which, and how questions.
	[17]	Journal		✓	Exposed some core concepts of blockchain technology and its applications

	[27]	Conference		✓	Aimed that show potential blockchain technology in the finance sector and many fields
	[29]	Journal		✓	Aimed to provide a general overview of blockchain technology
	[18]	Journal		✓	Need for detailed research of blockchain technology potential and implementation
	[19]	Journal		✓	Examined the key regulatory difficulties impacting blockchain US and EU
	[32]	Journal		✓	Bringing clarity energy consumption of Bitcoin and looking beyond these myths
	[21]	Conference	✓		Discuss the implementation of blockchain technology in e-government, especially in Chinese
	[22]	Journal	✓		Looking challenges and opportunities of the application of blockchain technology in the banking or finance field
	[33]	Journal		✓	Analyzing public key infrastructure and management for Bitcoin wallet
	[23]	Journal		✓	Presenting definition of the blockchain, DLT, chain, transparency, and related terms.
	[20]	Journal		✓	Aim that describe how BC works and discuss categories and potentials of BC.
	[24]	Journal		✓	Creating review for future study using of blockchain technology.
	[25]	Journal		✓	Discuss general information about blockchain technology inside IT.
	[26]	Journal		✓	The goal is summarized in the literature application in this paper.
	[30]	Journal		✓	Discuss how blockchain will impact of finance and audit industry.
	[31]	Journal		✓	Analysis of blockchain technology and its pros, cons, and types in the crypto-currency transactions
	[15]	Journal	✓		Define the first peer-to-peer electronic cash and online payment system.
	[16]	Journal	✓		Presented a smart contract system with decentralization and defined security protocol.

Supply chain	[41]	Journal	✓		Aims to recognize the interdependencies Between the challenges for new mathematical models (blockchain) supply chain
	[42]	Journal		✓	Give information about blockchain technology in the logistics sector and usage in the supply chain.
	[43]	Journal		✓	Encourage blockchain studies in supply chain management and define potential areas of implementation.
	[44]	Journal		✓	Review of the literature about the potentials, and trends and consider supply chain management with blockchain technology
	[45]	Journal		✓	Discussing BC entry supply chain field and increased risk and darkness points.
	[46]	Journal		✓	For future studies, it provides a direction and insight of the four barriers and categories.
	[47]	Journal		✓	Defined some cyber treatments of the blockchain system and how blockchain will react to this situation.
	[40]	Journal		✓	Created a literature review about combating of copying permissioned blockchain technology
Energy	[39]	Journal	✓		The aim of the study that shows the contribution of blockchain to circular economy for energy management
	[32]	Journal		✓	Bringing clarity energy consumption of bitcoin and looking beyond of these myths
	[37]	Journal		✓	Mentions about energy certification systems and enabling a blockchain system
	[36]	Journal	✓		Presented idea of renewable energy management system with blockchain technology.
	[38]	Journal		✓	Prove of comprehensive work of the fundaments blockchain technology
Agriculture	[48]	Journal		✓	Providing both technical and application surveys about blockchain technology in the agriculture field.

	[49]	Journal		✓	Examining the implementation of BC in the agricultural products with the theoretical and practical way
Education	[50]	Journal		✓	Give some core knowledge about blockchain technology and its advantages for education
	[51]	Journal		✓	Provides critical analysis of implementation blockchain technology in the higher education.
Construction	[52]	Conference		✓	A literature review was presented on how and where blockchain technology can be of use in the construction sector.
	[53]	Journal	✓		Investigating potentials of blockchain technology in the construction sector
	[54]	Thesis	✓		Focus about construction field general problems and how problems can solve with blockchain technology
Smart Grid/ Building	[55]	Journal		✓	Discussed that emerging blockchain and its contribute to how can help smart grid developing
	[56]	Conference			Mention about security perspective of blockchain in smart cities and smart devices.
Health	[59]	Conference	✓	✓	Describe Health Chain and why Blockchain Technology should be used health sector.
	[62]			✓	Discuss the potentials of blockchain in the healthcare industry today and future applications
	[63]	Journal		✓	Systematic review of blockchain technology applications in healthcare.
	[65]	Journal		✓	Studied important benefit of blockchain technology in the healthcare field and define fourteen implementations.
	[57]	Conference		✓	To demonstrate the potential, goals and impact of blockchain technology in healthcare.
	[60]	Journal		✓	The study about blockchain potentials and implementation areas in the health field
	[61]	Journal		✓	Focused in implementation blockchain technology healthcare sector

	[58]	Journal		✓	Presenting potential impact of BC in the clinical trial
	[64]	Journal		✓	Presented using blockchain technology in the healthcare sector
	[66]	Journal		✓	Highlighted potentials of blockchain technology in healthcare industry
	[67]	Journal		✓	Provided a literature review about the important role of BC in healthcare field with Covid-19
Law	[68]	Journal		✓	Providing a different perspective about legality in blockchain.
General definitions	[14]	Journal		✓	Giving deep information about blockchain technology, its history, consensus algorithm, smart contracts and cryptography mechanisms.
	[11]	Journal		✓	Providing general historical background, architecture, manner of work, pros and cons, and applications in different sectors
	[9]	Journal	✓		Providing such widely trusted computer systems and cryptographic techniques.
	[69]	Journal	✓	✓	Aimed that fill the gap in the literature and examine such proposals for governmental issues
	[34]			✓	Described blockchain technology beyond Bitcoin and give examples from different sectors.
	[35]	Journal		✓	Present a systematic mapping by collecting all relevant research.
	[12]	Journal		✓	Present a perspective to identify blockchain algorithm and architecture and also the security part.
	[70]	Journal	✓		Detected the aspects that need improvement in the architecture of blockchain and IoT systems
	[71]	Journal		✓	Defining blockchain adoption and its technological development
	[72]	Conference	✓		Discussing difficulties and security problems of blockchain technology in IoT.
	[73]	Journal			Tried to comprehensive survey and discussing BC architecture, challenges, and opportunities

2.2. Smart Building

The literature review has identified six key Smart Building topics. The analysis of the literature on the keyword Smart Building reveals 45 studies conducted between 2010- 2022. The studies primarily focus on energy management, remote control, and IoT subheadings. It is noteworthy to mention the countries where the studies were conducted, with the top three being USA, India and Türkiye. Upon examination of the literature, the majority of research articles found are review articles published in academic journals. This section presents a comprehensive literature review addressing the questions posed. While prior research has investigated smart building technology, this study distinguishes itself by critically evaluating the feasibility of integrating smart building technology with blockchain technology from an architectural viewpoint. [74] are among the researchers who have examined the complexity of terminologies and the objectives defining the smart building terminologies utilized in the industry.

The majority of studies have focused on energy management. [75] discuss the HVAC system and its requirement for dynamic control. According to their paper, unifying inputs to the HVAC controller is crucial for improving energy efficiency. Furthermore, the article details the development and implementation of an affordable, easily distributed occupancy detection system utilizing battery power. [76] examining the performance of a variety of energy storage vehicles in a microgrid was undertaken. These were subsequently compared. [77] aim to calculate energy consumption in smart homes using mixed integrated linear programming (MILP). This program was designed to operate the energy consumption in the smart building at the same time it provides real-time electricity pricing. [78] this study aims to analyze the latencies between smart home devices via the ZigBee protocol. Smart home appliances such as fridges, dishwashers, air conditioning units, washing machines, water heaters, ovens, and televisions are integrated with smart plugs. ZigBee, a communication technology between devices, is utilized in this study to manage WPAN and the communication nodes of device-to-device networks. In conclusion, ZigBee provides sufficient communication performance. [79] conducted analysis on Smart Building Energy Management Systems (SBEMS) and Conventional Building Energy Management Systems (BEMS) in relation to energy consumption and management. The results indicated that SBEMS led to a reduction in waste energy consumption. [80] proposed an agent-based approach to optimize the inter-operation of smart grid and building energy management systems, comparing them with multiple numeric examples. [81] presented the advantages and disadvantages of using AC and DC distribution systems for energy efficiency in smart houses. [82] aim to develop a new framework for managing energy in commercial buildings with a two-level grid. The study presents a bidirectional building-to-grid optimization approach based on experimental data. [83] describe a platform-based methodology for designing smart buildings and explain the various design components. [84] aim to develop a new deep learning algorithm for controlling energy consumption in smart buildings, and the paper presents a comparative analysis of predictive models. [85] demonstrate that a transfer learning system can be used to develop an intelligent human counting system. Thus, energy management over other methods. In their study, [86] discuss the potential risks of cyberattacks in smart home (SH) energy management and the formulation of energy consumption using devices in smart homes. [87] identified three types of smart home technology applications, namely, a) energy management, including monitoring of energy consumption and efficiency, b) the utilization of AI technology and machine learning algorithms, and c) the implementation of aged-care systems and wearable health monitoring systems. In a study, [88] compared machine-learning-based solutions for occupant-centric and device-centric/energy-centric approaches. Previous research has mainly concentrated on energy efficiency and recommended real-time monitoring and actuation. However, this paper proposes the use of machine learning to predict user behavior. [89] aimed to provide a comprehensive literature review on energy management in smart buildings. The review objectively examines existing structures and systems, while emphasizing the flow of information and causal connections between statements. Building Information Modelling (BIM) is employed for energy management, heating, ventilation and air conditioning operations, monitoring, and planning. [90] discuss challenges in smart building energy management and efficiency and provide a comprehensive literature review for smart building energy management and deep reinforcement learning keywords. [91] focused on predicting energy consumption using machine learning systems, working in a case study area in Malaysia. [92] introduced a novel model for energy management system which utilises Supervisory Control and Data Acquisition (SCADA) technology. [93] discuss multidimensional approaches to energy conservation, utilizing artificial intelligence to manage city infrastructures through machine learning techniques in smart buildings. [94] explore the requirements of smart cities, their energy sustainability, efficiency, and how urban planning impacts them. In their review, [95] examine developments in 5G technology and the influence of smart home applications. The text provides a detailed analysis of the features and opportunities of smart cities, as well as 5G use cases. The findings are based on a case study conducted in Singapore. The study suggests that advanced technology provides new opportunities, particularly in fields such as smart grids for cities, which are supported by 5G technology. Singapore serves as a prime example of this phenomenon. [96] highlights the effects of smart technologies on human life, including the potential for smart homes and the

creation of smart cities. One significant benefit of these developments is improved energy efficiency.

Sensor field studies figure prominently in the chronological sequence of related literature. [97] concentrated automation systems in smart buildings for energy management and recommended alternative systems for this purpose. [98] investigated indoor environment quality and energy savings through various sensor data. This paper provides a foundation for future studies and addresses challenges and improvements related to sensor types and fields of application. [99] examines the impact of pandemic situations on building consumption habits and the benefits of building-related vehicles for humans. They analyze these issues and establish a new area for future research. [100] introduce a novel software architecture for managing smart buildings that enables the use of a digital twin. This provides users with sensor data, which can be monitored in the digital twin software.

The third significant subheading focuses on IoT field studies within the smart building domain. These studies are listed below: [101] aimed at developing novel, efficient smart home control systems accessible via smartphones. It also describes the system architecture of IoT fog and cloud-based systems. [102] provided definitions for IoT, WIFI, and ZigBee, as well as the potential for sensor technology to be used in apartment monitoring and control. Sensor technology can be divided into various categories such as leak detection, smoke alarms, fire alarms, water and electricity usage monitoring, lighting control and heating systems. [103] discussed the emergence of feature implementation, control parameter and IoT infrastructure in this field. The paper suggests important changes for IoT-based control systems, with a particular emphasis on the need for a clear and logical flow of information and causal connections between statements. [104] propose the use of blockchain technology or a security and control framework to measure the effectiveness of these systems. This topic also explores the integration of IoT and BIM technologies. The reason for suggesting this system is due to the high number of stakeholders involved in the construction sector. A crucial aspect discussed in the paper is the adoption and integration of BIM and CIM. Their work also explores the design and application of an IoT-based cloud BEM system. [105] presents a comprehensive literature review on the optimization of energy consumption in smart homes. Technical abbreviations will be explained upon first usage. Quotes are clearly marked and filler words are avoided. The majority of researchers have prioritised indoor comfort in accordance with established standards. [106] propose a secure and transparent internet of things (IoT) control and management system for smart buildings. This is achieved through the use of software-defined networking (SDN) and blockchain technology. We've described how blockchain technology provides transparent security. The proposed system is intended to ensure that the IoT devices are controllable, highly scalable, and secure. [87] have identified three types of smart home technology use: a) energy management in smart homes, including monitoring energy consumption and efficiency, b) applications of AI technology and machine learning algorithms, and c) aged-care systems and wearable health monitoring systems. In their manuscript, [95] review and discuss the impact of 5G technology developments on smart home applications. The text thoroughly analyses the features and opportunities of smart cities and the use cases of 5G technology. The results are based on a case study conducted in Singapore. It was found that advanced technology presents new opportunities, and 5G technology provides substantial support for various fields, particularly for smart grids in cities. Singapore serves as a significant example of this phenomenon. [6] present an exploration of the Internet of Things (IoT) and its adaptation to smart homes (SH). While the advantages and disadvantages of this technology are recognized, the study aims to examine it from technical, technological, psychological, and human perspectives.

The second most researched subheading in this paragraph is "remote control," listed chronologically. [107], which offers software solutions for energy management in buildings. [108] proposed an IoT-based approach for controlling smart buildings. The authors aim to improve the efficiency and effectiveness of building management through the use of advanced technology. The study focuses on indoor localization, sensor data, and monitoring through IoT applications. Technical terms and abbreviations are explained for clarity, and the text is written in a clear, concise, and logical structure. [109] proposed a novel management system called Brick for intelligent buildings. It offers a clear understanding of tags and tag sets for specifying sensors. [110] introduce a novel technology called OCTOPUS, designed for enhancing energy efficiency in smart building energy consumption systems. [103] discussed the emerging implementation of features and controlling parameters in IoT infrastructure. This paper suggests significant changes for IoT-based control systems. [111] propose a real-time management system for smart buildings aimed at controlling various aspects such as indoor conditions, security, cost and comfort criteria, amongst others. [112] introduce a novel approach to gathering and contextualising essential post-occupancy data, comprising two distinct types. Additionally, the paper outlines innovative techniques applicable to BIM. The results of the study provide evidence of BIM's potential to function as a reliable single source of truth. Meanwhile, [99] analyse the effects of pandemic situations on building consumption habits and how building-related vehicles can benefit humans, shedding light on potential areas for future research. In their work, [6] discuss what the Internet of Things (IoT) is and why it should be adapted to the concept of smart homes. However, there exist pros and cons to this topic and technology. As such, this study aims to explore the technical, technological, psychological, and human perspectives associated with

it. [113] systematically examined the literature on Smart Building Energy Management Systems (SBEMS) and explored future studies and improvements for privacy and security. The paper provides detailed definitions of smart ventilation, heating, and air conditioning (HVAC) systems, lighting, plugs, windows, and energy optimization.

The primary goal of this study is to analyze blockchain technology and its related fields, including the security and control frameworks. [104] proposed measures to evaluate blockchain technology. Additionally, this topic encompasses IoT and BIM technologies. The construction sector is highly complex and involves a large number of stakeholders, making the implementation of this system particularly relevant. Another vital aspect discussed in the paper is the integration of BIM and CIM. [106] define an Internet of Things (IoT) control and management system for smart buildings based on software-defined networking (SDN), supported by blockchain technology for security and transparency. [114] Investigate the integration of technology in smart buildings and cities, including the use of blockchain for various applications such as information exchange and energy trading.

The smart grid or smart city is also a related topic under this heading. [115] aim to explain the characteristics of the smart building and compare them with the smart city context. And study showed that smart cities provided smart building integration. The authors mention EU and SRI ratings and standards. [80] Proposed an approach with agent-based for the optimised operation of the smart grid/building energy management system and compared with some numerical examples. [116] Discussed today's application of the smart building and the status of IoT in the smart city context. This paper showed different perspectives of smart city applications and used "souly" program for monitoring or managing the building. [94] smart cities and their requirements, energy sustainability and efficiency and how urban planning affects them. [95] review and discuss in this manuscript that 5G technology developments and how smart home applications are affecting this. The text analyses in depth the features and opportunities of smart cities and 5G use cases. All of these findings are examined through a case study of Singapore. The following result was obtained that advanced technology give new opportunities and 5G technology support to many field and especially smart networks, meaning cities. Singapore is the most important example for this. [96] express how smart technologies affect human life and potentials of smart homes and creating smart cities and one of the positive effects on energy efficiency. [114] investigate the integration of some technologies in smart buildings and smart cities and the use of blockchain technology, which gives some other options. For example, exchanging information, buying and selling energy.

Table 2. A brief summary of the literature review about smart building

Field	Author	Type	General	Review	Scope
Energy management	[89]	Conference		✓	Aimed to provide a general literature review about smart building energy managing.
	[88]	Journal		✓	Compared occupant-centric and energy or device-centric solutions machine learning based.
	[90]	Journal		✓	Offering a thorough and extensive review of literature on the application of deep reinforcement learning to smart building energy management.
	[75]	Conference	✓		Presented how to build and use a low-cost, battery-powered, distributed occupancy system.
	[83]	Journal		✓	Presented a platform-based methodology and defined components
	[77]	Journal		✓	Aim that calculate energy consumption in the smart home with using mixed integrated linear programming (MILP)

	[76]	Journal		✓	Analysis and comparison of the energy storage performance of various vehicles.
	[80]	Journal		✓	An agent-based strategy has been suggested to enhance the interoperation of smart grid/building energy management systems.
	[81]	Journal	✓		Presented DC distribution systems for using smart houses energy efficiency field.
	[84]	Journal	✓		Aim a new deep learning estimation for control energy usage of a smart building.
	[82]	Journal	✓		Aim a new framework for commercial building two-level grid to manage energy.
	[79]	Journal		✓	Analyzing SBEMS vs conventional BEMS.
	[91]	Journal	✓		Focus energy consumption predictions with using ML.
	[92]	Journal	✓		Presented a novel model of energy management based on the new model.
	[85]	Journal	✓		Demonstration of the use of transfer learning in the development of an intelligent human counting system.
	[86]	Journal	✓		Mention about smart home (SH) energy management and risks and consumptions using devices in smart homes
	[87]	Journal		✓	Aimed that presented types of smart home technology
	[93]	Journal		✓	Deep review of AI technology of smart home for smart building management systems
	[94]	Journal		✓	Investigating ways of smart grid promoting energy sector
	[95]	Journal		✓	Discussing 5G technology in the smart building examples in Singapore
	[78]	Conference		✓	Analyze the device-to-device communication with using ZİGBEE protocol.
	[86]	Journal	✓		Study in the effect of smart home devices on cyberattacks and some consumptions
	[96]	Journal		✓	The energy efficiency potential of smart city concepts is discussed.
Sensor	[98]	Journal		✓	Discussed types of sensor systems and using fields and contributions to smart building indoor environmental quality.

	[97]	Journal	✓		Focused automation systems for energy management. Proposed some alternative system for this.
	[99]	Journal	✓		Impacts of pandemic situations of building consumption habits.
	[100]	Journal	✓		Present a software for managing smart buildings with digital twin
IoT	[101]	Conference		✓	Aiming new and effective smart home controlling system from smartphone.
	[103]	Journal		✓	Discussed emerging implementation of features and controlling parameters and IoT infrastructure.
	[104]	Conference	✓		Proposed measure the blockchain technology for the security and control framework with BIM and IoT keywords
	[102]	Conference		✓	Presented some definitions of IoT, WIFI, zigbee… and how the sensor technology can develop in typical apartment monitoring
	[106]	Journal	✓		Define a SDN based IoT control and management system for smart buildings.
	[117]	Journal	✓		Describe application and design of IoT meaning cloud base BEM system
	[105]	Journal		✓	Focusing detailed literature review about optimization of energy consumption in smart home.
	[87]	Journal		✓	Aimed those present types of smart home technology
	[95]	Journal		✓	Discussing 5G technology in the smart building examples in Singapore
	[6]	Journal		✓	Aim to discuss IoT and adapt technologies of smart home
Remote control	[107]	Conference		✓	Providing a perspective of a software system to improve energy management in the buildings.
	[113]	Journal		✓	Examine literature for SBEMS and explore future study
	[103]	Journal		✓	Discussed emerging implementation of features and controlling parameter and IoT infrastructure.
	[109]	Journal	✓		Suggest a new management system for smart building.
	[111]	Journal	✓		A real-time control system for smart buildings has been proposed.
	[108]	Conference	✓		Suggested IoT-based approach for controlling in the smart buildings

	[110]	Journal	✓		Paper mentions about novel technology that name is OCTOPUS about controlling energy management.
	[99]	Journal	✓		Impacts of pandemic situations of building consumption habits.
	[112]	Journal	✓		Present a new process for collecting and contextualizing two important types of POE
	[6]	Journal		✓	Aim to discuss IoT and adapt technologies of smart home
Blockchain technology	[104]	Conference	✓		Proposed measure the blockchain technology for the security and control framework with bim and IoT keywords
	[106]	Journal	✓		Define an SDN based IoT control and management system for smart buildings.
	[114]	Journal		✓	Study in aspect linked to the application of smart grid citizens.
Smart grid/ city	[115]	Journal		✓	Aim that explain the features of the smart building and compare with the smart city context.
	[80]	Journal		✓	Proposed an approach agent-based for optimizing the interoperation of the smart grid/ building energy management system
	[116]	Journal		✓	Discussed nowadays application of the smart building and status of IoT in the smart city context
	[94]	Journal		✓	Investigating ways of smart grid promoting energy sector
	[95]	Journal		✓	Discussing 5G technology in the smart building examples in Singapore
	[96]	Journal		✓	The energy efficiency potential of smart city concepts is discussed.
	[114]	Journal		✓	Study in aspect linked to the application of smart grid citizens.
General definition	[74]	Journal		✓	Discuss terminology complexity and aim that define used smart building terminologies in the sector.

2.3. Collaborative Work About the Smart Building and Blockchain Technology

This literature review encompasses collaborative works and focuses specifically on the keywords "blockchain technology" and "smart building" used in combination. The results of the investigation of seven new studies are presented chronologically. The majority of these studies are literature reviews from fields other than architecture. This information considers that the study assessed architectural perspective and hardware. [118] have analysed blockchain technology as a smart grid for energy usage in smart homes from a holistic perspective, investigating beyond just energy management and saving in individual homes to a larger scale. In conclusion, their findings indicate that TEM based on blockchain can be effectively implemented in practical IoT devices and has the potential to reduce overall costs by 25%. [119] examine the benefits of public and private blockchain technology in smart homes, particularly their ability to secure connections between IoT devices. Ensuring trustworthy devices and

connections are essential for smart homes, as is the effective management of data storage to enhance trust and security. The study also confirms the usage of Python 3.7 for blockchain. In summary, the application of blockchain technology contributes to enhancing the security of smart homes when compared to traditional IoT systems. [120] discussed an automated repair system for sensors using smart contract technology. The paper suggested integrating HEPA filters into blockchain technology. Another suggested approach is using Ethereum's architecture, which can be easily implemented on other blockchain platforms. [121] explored the use of blockchain technology in IoT-based supply chain environments. It is shown that this technology has the capability to achieve sustainability and is inevitable. The paper by [122] presents an objective overview of the potential of AIoT-based supply chain architecture. The authors discuss how BIM, IoT, and blockchain technology are employed in smart buildings. Specifically, the paper designs a secure trust management system for HVAC utilizing blockchain technology. [123] conducted a thorough literature review of blockchain technology integration in smart cities, analyzing its advantages and disadvantages. The topics of reliability, privacy, and accountability were emphasized in the context of smart cities. [124] examined the autonomous dispatching of energy consumption in the smart grid and found, through applied simulation, that it can effectively reduce the cost of distributed energy.

Table 3. A brief summary of the literature review about smart building and blockchain technology

Author	Type	General	Review	Scope
[118]	Journal	✓		Discussed as a smart grid with blockchain technology by considering energy use in smart homes from a holistic perspective
[119]	Journal	✓		Discuss public and private blockchain technology in smart home and their advantages with used iot devices in home connection
[121]	Journal	✓		A discussion of the supply chain environment and the use of blockchain technology in the AIOT context.
[122]	Journal	✓		Suggesting trust, securable HVAC managing system in smart buildings
[123]	Journal		✓	Critical analysis of advantages and disadvantages of blockchain technologies on the different field.
[124]	Journal	✓		Discussed autonomous dispatching of energy consumption in the smart grid
[120]	Journal	✓		Discussed automatically repair system on the sensors with smart contract way

3. RESULTS

Expanding on the results of our comprehensive analysis, which examined 45 articles on smart buildings, 69 articles focused on blockchain technology, and a mere seven articles exploring collaborative keywords, a nuanced understanding of the prevailing gaps in the literature arises. It is noteworthy that a cluster of 12 articles, among the total of 121 publications reviewed, intersect both blockchain technology and smart buildings. Upon further examination, only seven of these articles specifically cover the intersection, indicating a more concentrated yet restricted discussion on the connection between these cutting-edge fields. Additionally, a significant contrast is present in the civil engineering department's low representation of architecture, with only 13 articles directly relevant to this discipline. The discovery suggests that there may be a shortage of research output and professional involvement in the architecture and construction industry which requires further investigation and consideration. Furthermore, analysis highlighted a common pattern where many studies in

this field mainly rely on literature reviews instead of offering innovative concepts. This emerging trend calls for further innovative research to advance the discourse. Although the subject has various applications, it is evident that the primary resonance lies within the supply and energy sectors.

4. DISCUSSION

The integration of blockchain technology in smart buildings is becoming increasingly inevitable, driven by a surge in research and development addressing various architectural concerns. These include, but are not limited to, energy management, financial transactions, supply chain optimization, and advancements in construction technologies. Blockchain offers a decentralized and secure framework that enhances transparency, efficiency, and accountability in these areas. For instance, energy management systems can leverage blockchain to facilitate peer-to-peer energy trading, while supply chains can benefit from enhanced traceability and fraud prevention. Consequently, the convergence of blockchain technology with smart building systems promises to revolutionize the architecture industry by fostering more sustainable, efficient, and resilient infrastructures.

Recent developments in the domain of blockchain technology have inspired this project, which examines the effects of industrialisation on the world and humanity, and explores the application of blockchain technology in smart buildings. This study discusses integrating Blockchain technology into smart buildings by customising the general concept of smart devices. The literature review includes the latest articles and technological developments, providing a comprehensive analysis of the current situation. The insights offer a framework for future work aimed at addressing the identified gaps, promoting the intersection of smart buildings, blockchain technology and architectural considerations in the construction industry. The systematic literature review presents significant insights for informing future studies. The findings from this initial investigation suggest that examining integrating of blockchain into smart building systems, specifically within the domain of energy management, could enhance operational effectiveness. The review recommends that these particular keywords such as life cycle assessment, circular economy, and green building are best suited for interlinked subject matters.

DECLARATION of ETHICAL STANDARDS

The author(s) of this article declare that the materials and methods used in their studies do not require ethics committee approval and/or legal-specific permission.

AUTHORS' CONTRIBUTIONS

Duygu Savur: Collect data from the study and analyse the results. Wrote the manuscript

Şeyda Emekçi: Analysing data and leading to conclusions

CONFLICT of INTEREST

There is no conflict of interest in this study.

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