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Review

A Systematic Literature Review on the Revolutionary Impact of Blockchain in Modern Business

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Abstract: Blockchain technology and its business applications have attracted considerable scholarly interest, leading to a surge in academic studies. While this wealth of research is beneficial, it also poses challenges in identifying the most relevant publications. Despite the availability of survey articles, research on this topic remains fragmented and concentrates on specific industrial sectors. This review addresses this gap by providing a detailed literature analysis, highlighting key themes, recent advancements, the benefits of blockchain adoption for businesses, and associated challenges. This study employs a multi-method literature review approach called bibliometric systematic literature review (B-SLR), combining bibliometric analysis with systematic literature review (SLR) techniques. This review critically examines studies of blockchain adoption in modern business from 2017 to 2023. Our findings reveal a decline in academic publications on blockchain for businesses since 2023, along with a shift in core themes from traditional supply chains to exploring blockchain's role in environmentally sustainable supply chains, such as reverse logistics, green supply chains, and the circular economy. Additionally, there is an emerging focus on the role of blockchain in virtual environments, such as the metaverse and digital twins. Drawing from our analysis, we also present a theoretical framework and highlight ten crucial areas for future research.

Keywords: blockchain technology; adoption decision; business; literature review; conceptual framework

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1. Introduction

Blockchain technology has gained global attention since Bitcoin's inception 16 years ago. A simple Google Scholar query for "blockchain" yielded more than 800,000 academic publications on the subject. Although some scholars contend that blockchain technology existed in various forms before its introduction with Bitcoin in 2008, this innovation has created new opportunities for a broad range of applications across numerous industries.

The global expansion of businesses is largely attributable to technological progress. Among these innovations, Blockchain Technology has emerged as a pioneering force, presenting unparalleled prospects for companies [1]. Strategic investments in digital solutions may yield multiple advantages including improved decision-making capabilities, value generation for stakeholders, increased operational productivity, and long-term financial stability; however, choosing suitable technological solutions requires a deep understanding of the technology at hand. A blockchain is a continuously expanding set of cryptographically connected records known as blocks [2]. Although initially developed as a decentralized ledger for digital currencies, such as Bitcoin, blockchain technology has demonstrated its potential in several other practical applications beyond digital currencies. Consequently, many businesses have recently begun investigating blockchain-based solutions with their partners, aiming to maintain their competitive edge and avoid falling behind [3].Growing interest in blockchain technology has sparked researchers' curiosity in various use cases,

as demonstrated by the increasing number of studies conducted. Blockchain business use cases include supply chain management [4–6], financial services [7–9], data management [10], the Internet of Things (IoT) [11,12], healthcare [13–15], e-commerce [16,17], among various other applications. The primary strength of blockchain technology lies in its ability to transmit information securely without centralized oversight. Nevertheless, the absence of a third party necessitates consensus among all participants [18]. These and other potential challenges stemming from technological, organizational, environmental, and individual factors have prompted numerous studies to investigate the obstacles to blockchain adoption in business settings.

The existing literature on blockchain technology for businesses is highly fragmented, making it challenging to obtain a deeper understanding of its potential for business applications. Although numerous literature reviews have been published, they are dispersed across various topics and sectors. Previous review articles on the potential of blockchain technology in business have typically focused on specific applications or aspects. Some studies have concentrated on particular sectors, such as supply chain management [19–21], healthcare [22], and financial services [23,24]. Other studies are industry-specific [25–29]. Additionally, certain reviews exclusively examine either the advantages [30,31] or the obstacles [32–35] associated with blockchain technology.

To address this gap, this study reviews research on the impact of blockchain on modern business by examining major themes, recent advancements, and the evolution of research on blockchain adoption. Moreover, it identifies the potential benefits, barriers to adoption, and areas where further progress is needed. This comprehensive examination explores critical research areas concerning blockchain technology adoption by businesses, including how companies can leverage blockchain, the challenges involved, and whether blockchain is merely a passing trend or offers substantial long-term advantages. These considerations, along with other key questions, formed the foundation of this analysis. The following research questions guided this review.

1. What are the key research themes in the literature on blockchain technology adoption by businesses?
2. Which theories are prevalent in the literature on blockchain technology adoption by businesses?
3. What conceptual frameworks have been developed to analyze the dynamic between blockchain technology and business adoption processes?
4. What challenges do businesses face when adopting blockchain technology?
5. What benefits do businesses gain from adopting blockchain technology?

Given the inconsistency in theoretical frameworks for blockchain research, this study develops a conceptual model to elucidate the implications of blockchain adoption, drawing on existing studies. The analysis and model aim to help researchers and industry professionals grasp the current landscape by detailing the crucial aspects of the adoption of blockchain technology in business, highlighting emerging areas, and providing directions for future investigations. The remainder of this paper is organized as follows. It begins with a discussion of the theoretical underpinnings of blockchain technology, followed by an explanation of the methodology used in the literature review. Subsequently, the key findings of the review are presented, and a conceptual framework is proposed. This paper concludes by emphasizing the importance of this study, acknowledging its limitations, and suggesting avenues for future research.

2. Theoretical Background

Before the advent of Bitcoin in 2008, numerous academic publications proposed various system concepts that are fundamental to blockchain technology. These concepts, including public key infrastructure (PKI) and cryptographic hashing, were utilized in different contexts. In their study, Haber and Stornetta [36] introduced a method employing cryptographic hashing to validate document timestamps, which laid the groundwork for the immutable ledger concept central to blockchain technology. Although these predeces-

sor systems do not incorporate all the components that characterize modern blockchain technology, they establish an essential foundation for distributed ledger systems and play a crucial role in enabling blockchain functionality.

A blockchain is a distributed database or ledger of interconnected data blocks safeguarded against alteration using cryptographic techniques [2]. Blockchain is administered through the network's user agreement rather than a central authority. Each block owns a copy of the ledger in a blockchain network or relies on network participants for the blockchain data [37]. The data cannot be erased once it has been added to the blockchain unless all or most of the network participants agree, which is known as immutability. The amount of data continues to grow as additional blocks are deployed. Each block in the blockchain includes the preceding block's information, which safeguards the data alteration [38]

Smart contracts are advances based on blockchain's core technology concept, allowing customized functionality to be built on blockchain systems and the precise execution of automated agreements when the network terms are met [39]. One of the most progressive ideas for using smart contracts is to develop the nexuses of intelligent contracts to create decentralized groups and organizations that run autonomously (DAOs) [40]. Smart contracts are utilized in the blockchain to deliver various services to corporations, institutions, associations, and the general public, such as financial, notary, voting, and other services [41]. Following the initial popularity of blockchains with the introduction of cryptocurrencies, an attempt was made to continually utilize the technology for new applications [42].

3. Methodology

Databases, Document Inclusion and Exclusion Criteria

This study used a multi-method literature review approach known as bibliometric systematic literature review (B-SLR), which integrates bibliometric analysis with systematic literature review (SLR) techniques and theory development [43]. This approach facilitated a systematic and detailed understanding of the research subject. First, we crafted a search string to retrieve relevant documents aligned with the research questions and objectives. The search string used was: ("blockchain technology" OR "blockchain" OR "distributed ledger technology") AND ("impact" OR "effect" OR "influence" OR "transformation" OR "disruption" OR "adoption" OR "integration" OR "applications") AND ("business" OR "enterprise" OR "corporate" OR "organization" OR "industry" OR "management") AND ("modern" OR "digital" OR "contemporary").

Next, we selected the Web of Science (WOS) as the primary database for retrieving literature and conducting bibliometric analysis. Studies such as Singh et al. [44] highlighted that Web of Science is known for its rigorous selectivity compared to other databases, such as Scopus and Dimensions, ensuring a high-quality and focused set of publications for analysis.

In the third stage, we performed data screening and cross-checking using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) model [45]. The PRISMA diagram in Figure 1 illustrates the screening and selection processes. The initial search of the WOS database yielded 3728 records. After excluding 1269 documents that were neither research articles nor books and were not written in English, 2459 unique records remained. During the screening phase, we reviewed the titles and abstracts to exclude studies that were irrelevant or did not meet our inclusion criteria, further reducing the dataset to 1539 records for the bibliometric review.

In the fourth stage, we conducted a bibliometric analysis of 1539 records using VOSviewer. This analysis helped identify key articles, themes, and interconnections between various blockchain adoption concepts in business. Thematic analysis was performed by separating the studies into two distinct periods: 2017–2021 and 2022–October 2024. We included documents from 2024 to capture the latest trends and emerging developments in the field. However, the 2024 data is provisional, as studies published this year may not yet be fully indexed on the Clarivate platform. The process began with identifying and

analyzing themes from the earlier timeframe (2017–2021), followed by assessing the more recent trends and advancements observed in the latter period.

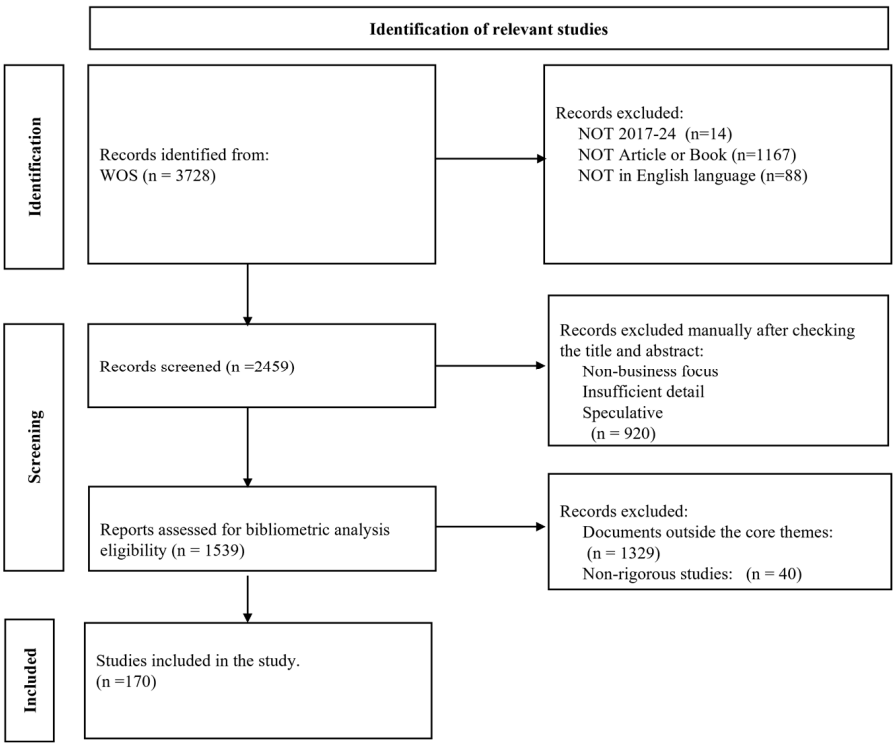

Figure 1. The identification and screening process using the PRISMA model.

In the final stage, we conducted a comprehensive examination of 1539 full-text documents to assess their relevance based on alignment with key thematic criteria and stringent quality standards. This process resulted in the exclusion of 1369 records, leaving a final collection of 170 studies. The remaining studies that satisfied all criteria were chosen as the primary dataset for conducting a theoretical synthesis and thematic analysis of the emerging findings.

4. Findings and Discussions

4.1. Publication Trends over Time

Figure 2 depicts the evolution of publications in the sample used for bibliometric analysis. The data indicate a growing scholarly interest in the subject over time. The early years saw limited publications accounting for approximately 7 percent of the total relevant documents. A notable increase occurred in the following three-year span, producing more than 55 percent of the total articles. This heightened attention from 2020 onward can be attributed to advancements in blockchain technology and the global digital transformation accelerated by the COVID-19 pandemic. This peak may also indicate a shift from initial exploratory studies to more advanced and specialized research as the field matures. In 2023 and 2024 (October), the number of publications declined slightly to 286 and 276, respectively, suggesting that blockchain research is now focusing on practical applications.

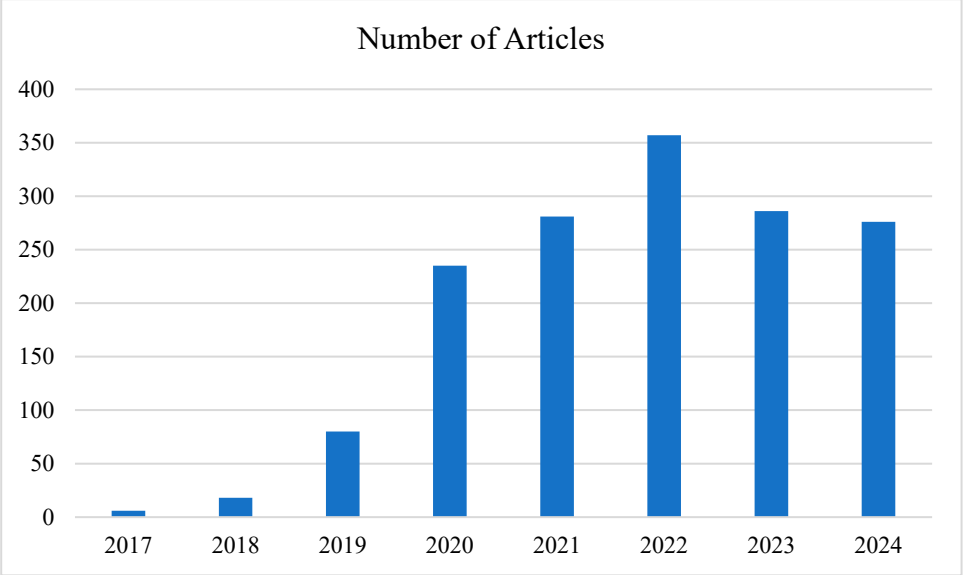

Figure 2. The number of publications over the years.

4.2. Co-Word Analysis

We used co-word analysis to identify core themes and recent advances in literature. Co-word analysis is a methodological approach that directly examines the content of a publication and maps its relationship. The core premise of co-word analysis is that words commonly co-occurring in the literature are likely to be linked by a thematic relationship, which helps identify clusters of related concepts. It identifies thematic relationships by extracting and analyzing words or phrases that frequently appear together in a text, typically sourced from author-provided keywords. In cases where author keywords are unavailable, keywords may instead be sourced from titles, abstracts, or even the full-text content of the articles [46]. The map in Figure 3 visually presents the initial findings, showing that in the 2017–2021 period, four main thematic clusters were formed. These clusters reflect key topics, such as supply chain management, healthcare data management, e-commerce, and the integration of blockchain technology with other emerging technologies, such as artificial intelligence, to drive value creation in business.

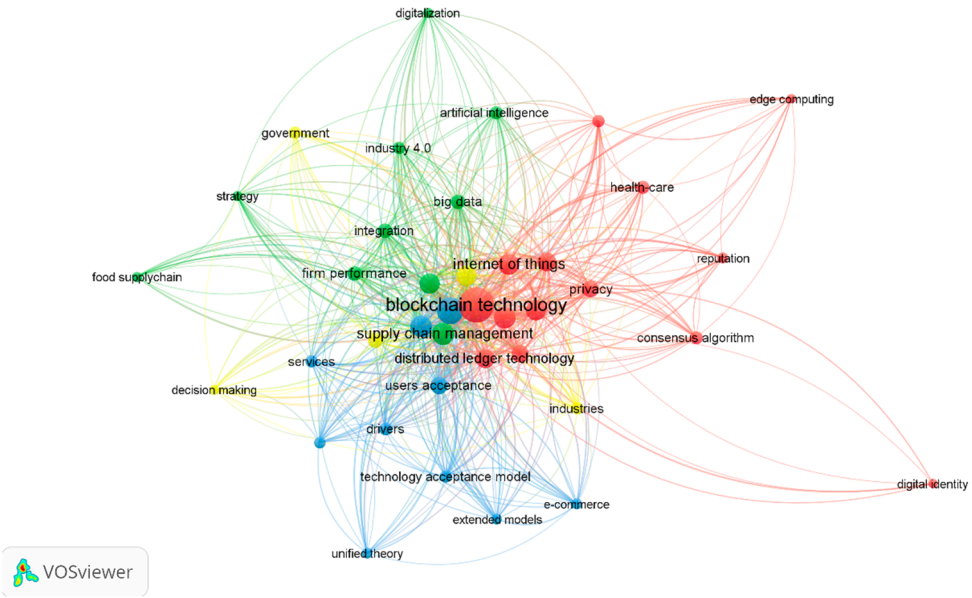

Figure 3. Co-word network (2017–end of 2021).

Figure 4 depicts the co-word network for the 2022–2024 timeframe. During this period, the number of thematic groups increased from the four clusters noted in the 2017–2021 period to eight clusters. We can observe a progression in thematic development, with topics becoming more refined and distinct within their respective clusters. For instance, while supply chain management remained the dominant cluster, its emphasis shifted towards environmentally conscious supply chains, reverse logistics, circular economic approaches, and initiatives that promote sustainability. This shows an increased emphasis on environmental- and resource-conscious practices. Furthermore, progress was noted in the impact of tokenization, along with the utilization of non-fungible tokens (NFTs), assets within the metaverse, and digital assets in generating value. The following sections present the core themes identified in both periods, followed by a discussion of recent developments.

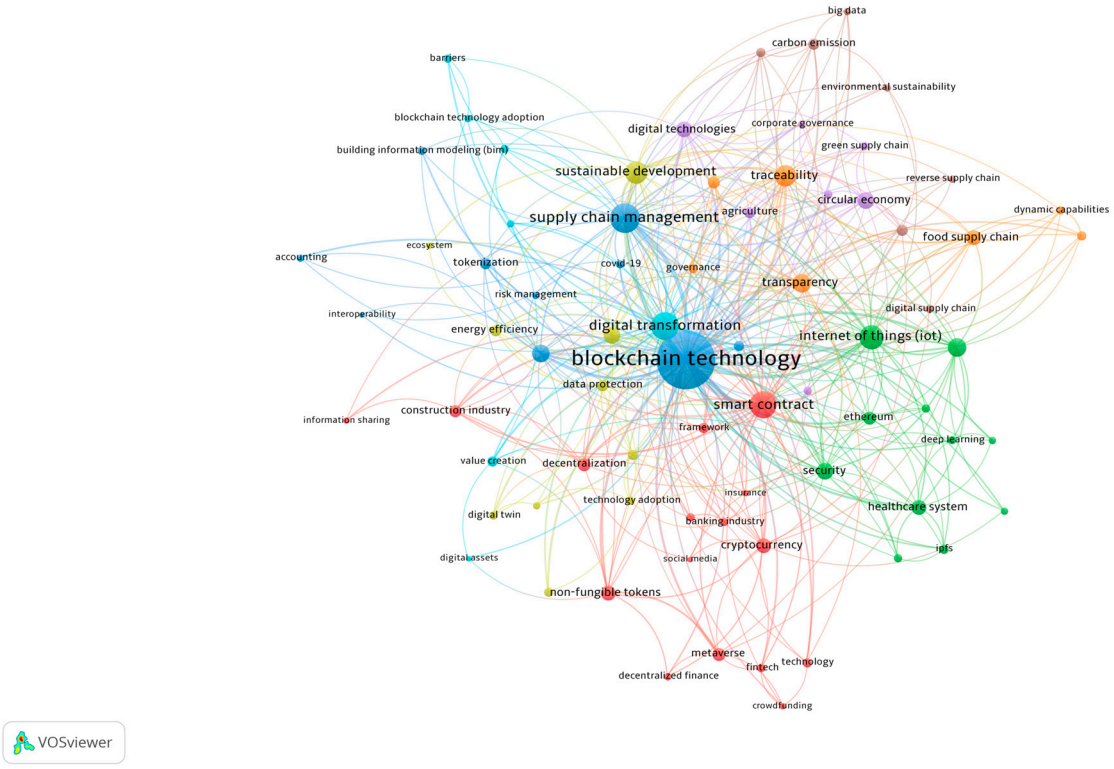

Figure 4. Co-word network (2022–October 2024).

4.3. Core Themes and Clusters

The adoption of blockchain technology in business has been the subject of numerous studies, resulting in the publication of multiple research papers examining its diverse applications. This section briefly discusses the themes. The analysis identified two primary themes across the two time periods, supply chain management and decentralized data management, along with their associated sub-applications.

4.3.1. Theme 1 Supply Chain Management

A prominent theme during both periods was the exploration of the impact of blockchain technology on supply chain management. Companies invest heavily in various technologies to create and maintain efficient, cost-effective, and viable supply chains [47]. Numerous studies have examined the potential of diverse blockchain-based systems for supply chains and the obstacles to their implementation. Although research suggests that blockchain technology may transform future supply chain management, the current literature indicates that its application in this field remains at an early stage [48–51]. The following are some of the functions of this technology in supply chain management identified in various scholarly studies.

Logistics Tracking and Tracing

Research has shown that blockchain technology offers potential benefits, such as reducing transaction expenses and enhancing logistics performance. It achieves this by simplifying product tracking and providing advanced methods for safeguarding and compiling product information, which can be used for verification, origin determination, and quality assurance [52–54]. In addition, it may facilitate the development of shared manufacturing and digital systems [55]. This is particularly crucial in contexts where supplier reliability and product conditions are vital, such as food supply chains. In these scenarios, meticulous record-keeping and constant monitoring of goods' locations are necessary to prevent spoilage or to substantiate claims like natural ingredients, organic cultivation, or religious certifications, such as kosher or halal [56].

Supply Chain Data Reconciliation

Research has shown that blockchain technology can be used by supply chain participants to exchange information on sales, supply, and inventory. This data can be selectively shared across various stages of the supply chain, leading to enhanced coordination and operational performance. Furthermore, Dobrovnik et al. [57] highlight that implementing blockchain-based smart contracts to automate transactions between supply chain partners can further enhance coordination and operational efficiency.

Research has shown that before adopting blockchain technology, organizations need to address several key areas for improvement. These include developing advanced information systems for gathering, processing, and transmitting data [58]), acquiring specialized and cutting-edge technical expertise (Kurpjuweit et al., 2021) [55], reaching agreements among supply chain partners regarding operational protocols and data-sharing specifications [59], and confirming that customers are interested in accessing traceability information and other blockchain-stored data [60]. Additionally, Khan et al. [61] stressed the significance of comprehending the processes involved in creating standards and benchmarks for interoperability between various blockchains and their associated protocols.

4.3.2. Theme 2 Decentralized Data Management

Businesses employ data for various purposes including asset monitoring, financial management, and global workforce coordination. Current studies on the integration of blockchain technology in business highlight its capacity for decentralized data management across multiple domains. These applications include IoT networks, medical information systems, and financial data oversight. The following sections provide detailed explanations of each of these cases.

Medical Record Data Management

Research has shown that conventional healthcare systems are rapidly adopting sophisticated technologies to evolve into intelligent systems [14,62,63]. Blockchain technology is viewed as a powerful tool for establishing an interconnected, intelligent healthcare environment, in which information can be shared among all healthcare entities [14]. The advantages of blockchain technology (BCT) include decentralized data storage, protection of confidential patient and clinical information, and patient-centric solutions that enhance the efficiency of the healthcare sector [10]. Nevertheless, numerous studies have identified several obstacles and concerns regarding intelligent healthcare systems, particularly in the areas of data security, transparency, and privacy [14,63].

Several literature sources indicate that the implementation of blockchain-based systems for managing medical data has faced obstacles due to governmental regulations, including data protection laws (such as GDPR and similar legislation), individuals' rights to data erasure, and various privacy-related issues. Considering these challenges, Przhedetskiy et al. [64] highlighted the need to prioritize patient privacy and foster strong collaboration with authorities to effectively boost the adoption and expansion of blockchain technologies in medical applications. Additionally, Mackey et al. [65] proposed that medical applications

utilizing blockchain must be sufficiently flexible to conform to the rules and privacy laws established by each nation's healthcare and technology regulations. Nevertheless, Yeung [66] contends that blockchain technology is unlikely to revolutionize healthcare soon.

Financial Data Management

Early research suggests that the rise in cryptocurrencies could potentially disrupt the banking industry and lead to adverse effects. Nevertheless, some analysts view this development as an opportunity for financial institutions to enhance their operational systems by integrating blockchain technology into their infrastructure. Research on blockchain in financial data management primarily examines its implementation in the banking and insurance sectors from two perspectives. The first is customer-oriented, in which financial institutions adopt blockchain-based payment systems to enhance transparency and safeguard transaction integrity during the banking process. This approach aims to mitigate data breaches and cybercrime, which are common in the banking sector, as financial organizations explore innovative methods to protect customer information and reduce cyber threats [67,68].

The second perspective evaluates the potential of blockchain technology in the finance industry as a viable and transparent option for retrieving data and transactions among companies [69]. Additionally, researchers such as Rijanto [8] have explored opportunities for collaboration and data sharing between the banking and insurance sectors to improve credit and risk assessment methods. Business strategies have also been examined, in addition to their operational aspects. Saheb and Mamaghani [1] identified the strategic motivation for blockchain adoption as one of the least crucial organizational values in banking. Nevertheless, Nazim et al. [70] note that financial institutions are drawn to blockchain-based solutions to maintain their leading position in supporting digital transformation.

Studies on the adoption of blockchain technology in finance have highlighted several organizational benefits, including increased reliability, enhanced quality control, improved data integrity, and greater validity of business processes [1,68]. Furthermore, research has examined blockchain's applications in the insurance sector, noting its capacity to accelerate and simplify insurance claims while enhancing fraud-detection capabilities [71]. Various studies have guided the effective implementation of blockchain-based systems in the financial sector. For instance, Kulkarni and Patil [72] emphasized the importance of finance industry participants' thorough understanding of blockchain technology to incorporate it as a fundamental element of their services. Raddatz et al. [68] indicated that users are more inclined to adopt blockchain-based applications when organizations demonstrate knowledge of the technology and address public concerns about data security, particularly concerning privacy issues. Grima et al. [71] emphasized the importance of clearly communicating blockchain's potential applications in various insurance processes to maximize its benefits. Regulatory bodies are also advised to develop guidelines and standards to ensure the long-term viability and progress of the technology [7].

Internet of Things

As observed by Al-Khazaali and Kurnaz [73], current IoT architectures face various technical challenges, including issues with data security, transmission, and compatibility, owing to their centralized structure. Recent studies have explored the potential of integrating blockchain technology into IoT systems. This combination offers several advantages, such as enhancing data protection [74], fostering greater trust among interconnected systems [75], and reducing the likelihood of collusive behavior [73]. Integrating IoT and blockchain brings up new possibilities for the parties involved by reducing inefficiencies, enhancing security, and improving transparency, while enabling safe machine-to-machine communications [73]. From a business standpoint, the combination of IoT and blockchain is anticipated to enhance database management and streamline operational processes, such as procurement [76] and the development of smart organizations. However, research has identified various obstacles to its implementation. For example, Khor et al. [74] empha-

sized that, from a technical perspective, the limited processing power of IoT networks, owing to their reliance on rechargeable batteries and sensors, complicates the integration efforts. For the successful integration of IoT and BCT, it is vital to understand the technical characteristics that a blockchain should possess to be integrated into the IoT [74].

E-Commerce

The decentralized nature of blockchain technology has also been recognized as an asset for e-commerce. Studies have shown that incorporating blockchain into e-commerce enhances security and privacy, thereby providing superior customer protection for customers [77]. Moreover, it facilitates data sharing by providing identical transaction information to all parties in the B2B network, thereby boosting customer loyalty [16]. Additional benefits of merging blockchain with e-commerce include authenticated reviews and ratings, personalized products, reduced fees for cross-border transactions, attracting cryptocurrency enthusiasts, and broadening customer demographics [17].

4.4. Recent Advances and Emerging Clusters

4.4.1. Sustainability-Oriented Supply Chains

Between 2022 and 2024, research on blockchain technology in supply chain management has increasingly concentrated on promoting sustainability efforts, with a particular emphasis on environmentally friendly supply chains, circular economies, and reverse logistics. Ismail et al. [78] suggested that blockchain technology can improve transparency in green supply chains, enabling companies to monitor materials and manufacturing processes to comply with environmental regulations and decrease their carbon emissions. Reverse supply chains can also benefit from blockchain technology. A reverse supply chain refers to the return of products from consumers to manufacturers for recycling, refurbishment, or disposal [79]. In the view of Zhang et al. [80], blockchain facilitates precise tracking and verification of returned goods for recycling or refurbishing, aligning with corporate sustainability objectives. In the context of a circular economy, Chen et al. [81] contend blockchain aids in sustainable resource utilization by monitoring the entire lifecycle of products, from production to disposal, thus streamlining reclamation efforts and waste reduction.

Nevertheless, research suggests that several challenges continue to impede the effective implementation of blockchain technology in sustainability-focused supply chains. These challenges include substantial setup expenses, opposition from the involved parties, and insufficient support from top management, all of which collectively hinder adoption. Naseem et al. [79] note that for blockchain to be successfully integrated into sustainable supply chains, its advantages for a business must significantly outweigh these barriers.

4.4.2. Digital Finance and Assets: DeFi, Digital Assets, and NFTs

Another recent advancement in blockchain technology is its financial applications and ways in which a business can leverage these innovations. Research has increasingly focused on decentralized finance (DeFi), digital assets, non-fungible tokens (NFTs), and tokenization. Tokenization refers to the process of converting real-world assets, such as real estate or artwork, into digital tokens on a blockchain [82]. Although previous studies have touched on the benefits of DeFi, NFTs, and tokenization, they have received limited attention. Recent research and development have aimed to enhance accessibility, user experience, and security in these areas, tackling challenges such as liquidity, scalability, and regulatory compliance [83]. Additionally, NFT applications have expanded across various industries, creating new opportunities to authenticate, trade, and monetize digital assets. Recent studies have also addressed the environmental impact of NFTs, focusing on developing sustainable blockchain solutions to meet the growing demand for digital collectibles [84,85].

4.4.3. Virtual Environments: Emerging Focus on the Metaverse and Digital Twins

In recent years, research has increasingly focused on blockchain's potential in the metaverse and digital twins. The metaverse is a virtual environment in which users engage

with computer-generated surroundings and other participants to create immersive digital experiences [86]. Yaqoob et al. [87] highlight that blockchain technology is essential in the metaverse, facilitating compatibility across different platforms and enabling economic systems through digital goods and services. Furthermore, the incorporation of blockchain empowers users to safely possess and exchange virtual assets within a metaverse ecosystem [88]. This functionality allows individuals to acquire digital real estate, participate in community activities, and conduct business transactions in a virtual environment. Nevertheless, according to Li et al. [89], the technology behind the trusted collaborative network that supports the metaverse is still in its early stages. They argued that using blockchain as the underlying trusted collaborative network for the metaverse poses significant security and privacy risks, making it susceptible to breaches.

A digital twin is a virtual representation of a physical entity, system, or procedure. It utilizes real-time sensor data to accurately reflect the real-world equivalence. Blockchain technology enhances digital twins by safeguarding data exchanges, maintaining data integrity, and generating unalterable records, which is especially crucial in scenarios where trust and verification are paramount. Recent studies, such as those by Tavakoli et al. [90], have highlighted the significance of blockchain in predictive asset management (PAM) for building facilities through the creation of a data provenance framework for blockchain-enabled digital twins. This framework offers a transparent and immutable log of data origin, ownership, and history, thereby bolstering the dependability and credibility of data in PAM.

4.5. Theoretical Frameworks and Models in the Literature

4.5.1. Value Creation Using Blockchain

Several studies have used various theoretical frameworks, each with a unique perspective on value generation. Each source of value creation is founded on a well-established theoretical framework, such as value chain analysis, resource-based views, and network theory. These studies primarily focus on how businesses benefit from blockchain technology. The resource-based view (RBV) focuses on a company's long-term value creation and strategic resources. If a resource is helpful, unique, difficult to copy, and non-substitutable, a corporation considers it a source of sustainable competitive advantage [91].

Researchers have discovered that when blockchain technology is coupled with existing resources and capabilities, it may be leveraged to generate dynamic capabilities that lead to improved performance and competitive advantage by boosting the transparency and dependability of business processes by strengthening collective capacities and developing blockchain-specific capabilities [92,93]. These studies primarily focus on how businesses benefit from blockchain technology. The theories used in the reviewed literature are summarized in Table 1.

Table 1. Description of value generated by businesses' BCT adoption.

Theories Used	References	Type of Value	Approach	Outcomes	Challenges	Solutions
RBV	Kant [92], Nandi et al. [94], Tipmontian et al. [95]	• Generate dynamic capabilities • Improve performance	When exploited through a business model	• Boosting the transparency • Improving the dependability of business processes • Build adaptive capacity for market changes	The number of applications grows.	Constant adjustment
RBV with Network Theory	Paul et al. [96]	• Assist in adapting to structural market shifts • Creating a competitive advantage		• Strengthening collective capacities • Enhancing strategic alignment with business models	No sufficient utilization by a corporation as a strategic resource	Foster organizational buy-in for strategic resource use
RBV with Game theory	Kumar [97]	Improve expected profit		Developing blockchain-specific capabilities		

4.5.2. Organizational Theories: Drivers of BCT Adoption

Following up on our research, we discovered that the literature strongly emphasizes behavioral and organizational aspects that influence organizations' adoption of blockchain technology. Several behavioral and organizational theories have been used to understand the adoption of blockchain drivers and inhibitors in business. Because of its flexibility to look at different aspects of organizational factors that influence blockchain acceptance and usage, the technology–organization–environment (TOE) [98] is frequently used. Constructs from the diffusion of innovation (DOI) [99] have also been frequently used in the literature on the diffusion of blockchain among enterprises. Considering this, various studies have applied the theory to understand how blockchain technology spreads among individuals in organizations, diffusion time, and technology status.

4.5.3. Behavioral Theories: Behavioral Determinants of BCT Adoption

Several models, such as the unified theory of acceptance and use of technology (UTAUT), its extension UTAUT2 [100], and the technology acceptance model (TAM) [101], have been used to study users' intentions and factors influencing their behavioral intention to adopt blockchain technology. The essential variables identified in the research on behavioral intentions for blockchain technology adoption are listed in Table 2.

Table 2. Description of determinants of BCT adoption in business.

Category	References	Determinants	Facilitators
Technological factors	[93,102–111]	Technological maturity, Confidentiality, Transaction speed, Scalability, Network attacks (threat of a 51% attack), Security and privacy, Cost and Efficiency.	Decentralized management [107,108]; Immutability [109,110], Data security [111], Traceability [110,112] and Enhanced transparency [93].
Organizational factors	[2,113] Rainero and Modarelli [60] highlighted use of blockchain technology as corporate social responsibility (CSR)	Availability of specific blockchain tools, Infrastructural facilities, IT knowledge of employees, and initial cost for the infrastructure. Organizational readiness, Organization's complexity, and An organization's strategic orientation.	Organizational innovativeness, Organizational learning capability, Top management support, Skilled professionals.
Environmental factors	[35,108,114–118]	Trading partner readiness, Environmental Responsibility	Government support [107,116], Trading partner support and collaboration [35,117], and customer support [118].
Behavioral factors	[49,67,102,114,119–124]	• Social influence • Perceived ease of use • Perceived usefulness (performance, cost, efficiency expectancy) • perception of risk • Trust (or distrust amongst stakeholders)	Managers' technological curiosity or learning [124], Managers' risk-taking behavior, and Corporate leaders and managers' familiarity with the benefits of blockchain technology [102,123].
Moderating factors	[125,126]	Technological characteristics • Privacy • Transparency of information • Security and • Reliability	Affects • Perceived usefulness • Perceived ease of use • Trust

4.5.4. Moderators and Mediators

Moderating Variables

Various moderating variables have been considered in studies on blockchain adoption in business. For instance, age, education, and income level were found to be insignificant in influencing an individual's behavior toward user-oriented blockchain system adoption [127]. Moreover, a study by Shrestha et al. [128] emphasized that trust has a moderating effect on the perceived privacy of blockchain-based systems. As a result, the study highlighted that, when creating blockchain-based systems, special consideration should be given to boosting user trust and perceived privacy. Furthermore, Mubarik et al. [129] validated technological orientation as a moderator in the interaction between blockchain technology and green supply chain practices, thus strengthening the association. Experience was also found to positively influence the continuous use intention of user-oriented blockchain-based systems [130].

The moderating role of the economic status of developed and developing countries in influencing the intention and behavior for using blockchain technology has also been researched [8,131,132].For example, in developed countries, the desire to use blockchain technology is primarily influenced by rules, awareness, business responsibilities, and legislation. Social influence from colleagues and family members has a substantial indirect impact on blockchain adoption in developing and emerging countries by influencing adoption intentions.

Mediating Variables

Several mediating variables have been investigated in research on adoption of blockchain in business. For example, from a performance perspective, Hye et al. [53] addressed the link between a company's IT capability, staff service quality, and e-logistics in logistics and supply chain performance. This study demonstrates the role of blockchain as a mediator in the IT capacity, staff service quality, and e-logistics of a business. Other studies have focused on the elements that influence individuals within a business's decision to use blockchain technology. For instance, Shrestha et al. [128] studied the mediating roles of trust, security, and privacy in BCT adoption. The mediating role of innovation resistance in the financial sector's adoption of blockchain in the financial sector [133] has also been highlighted. Koh et al.'s [133] study confirms the positive impact of blockchain on green supply chain practices and reveals the mediating role of environmental orientation in this relationship. Moreover, technological orientation has been confirmed as a moderator, strengthening the relationship between blockchain technology and green supply chain practices [129].

4.6. Conceptual Frameworks Developed in the Reviewed Literature

Prior research has presented numerous conceptual frameworks and models to explain blockchain acceptance and use with several key points. To simplify comprehension, we categorize them as user, business, and ecosystem oriented. The most relevant conceptual frameworks developed in the literature on blockchain technology adoption are listed in Table 3.

To summarize, these studies have contributed to the theoretical and practical aspects of blockchain technology across various industries, emphasizing the importance of a business understanding these frameworks and how they can help the business outline the necessary measures for improving the organizational operations, thereby contributing to long-term industry sustainability. The following sections explore the implications and challenges associated with the adoption of blockchain technology in business.

Table 3. Conceptual frameworks developed in the reviewed works of literature.

Frameworks	Purpose	Applied	References	Benefits
User Oriented	• Improving the user experience	• Health	• Zhuang et al. [134]	• Gives patients complete control over their health data (records).
	• Enhancing the wage experience of workers • Improving the worker-employee relationship experience.	• HRM (Integrated project delivery based on risk/reward sharing)	• Elghaish et al. [135]	• Allows core project team members to conduct all financial transactions.
Business oriented	Managers' decision aid model, Assists managers in devising effective strategies, • Enhancing businesses' collaboration • Improving adaptability, alignment, and agility • To improve staff service quality	Service industry	[53,93,136,137]	Helps managers efficiently implement blockchain technologies by identifying the cause-and-effect relationship among the barriers to adoption.
Environmental Oriented	• Initiate and facilitate participants' readiness for application and blockchain adoption.		• Lustenberger et al. [18]	• Highlights the distinctions between permissioned and permissionless blockchains.
	• Emphasizes socioeconomic benefit of blockchain adoption at the ecosystem level		• Toufaily et al. [105]	• Identifies new structures in blockchain technology adoption.

4.7. Outcomes of BCT Adoption

Although the adoption of blockchain technology in business is minimal, the literature has proposed several potential benefits and outcomes that businesses can gain by adopting it. Studies have addressed the effects of blockchain technology on the perceived benefits and uses, expected outcomes, and impacts. These variables are based on subjective experience, which can vary depending on a business's structure and culture, geographic area, the traits of managers and employees, and familiarity with technology. The term 'implications' was used in this review study to describe the outcomes of blockchain technology adoption and was categorized into value creation and improved business processes.

4.7.1. Value Creation

The literature highlights several ways in which organizations can gain value from BCT adoption, including its impact on internal operations [138], adding socioeconomic value [139], better stakeholder engagement [140], marketing [130], and customer service [141]. Another potential application of blockchain technology in a business's value creation is fostering innovation. The effect of blockchain adoption on innovativeness has been documented in the literature. Studies indicate that businesses in developed nations perceive BCT as a new instrument to strategically drive innovation and improve the traditional industrial system [142].

4.7.2. Business Process Enhancement

Several studies have investigated how blockchain can substantially improve the business processes of various companies. One of the main considerations is the use of blockchain technology in quality assurance within the supply chain to track raw materials and finished products. This method provides detailed tracking information to all external parties in the supply chain, which can help prevent counterfeit items from entering the channel and ensure the preservation of product quality [58]. Other quality assurance stances were

in the insurance industry to handle claims and other activities [71]. Furthermore, the research emphasized the potential of blockchain technology to reduce data redundancy and increase collaboration, potentially resulting in efficient and low-cost business processes [143]. For instance, Chang et al. [144] highlighted the potential of BCT to facilitate coordination in international trade processes, mainly in the transmission of documents and information between process participants, where there is a lack of trust by reducing intermediaries, transaction time, and cost, particularly in the case of L/C payments. Agility and sustainability are also critical areas for BCT adoption in business process improvement.

According to studies, BCT's "smart contract" attributes, which automate the execution of actions as specified, can help corporations execute contracts without delays, potentially assisting in managing agile business processes [95]. For example, Shin et al. [130] highlighted that blockchain has the potential to have substantial implications for future marketing as an efficient automated contractual system to improve user experience, customer loyalty, and tracking behavior. Other highlighted outcomes of BCT adoption in the business process include efficient cash flow [145], enhanced logistics [53], and secured data transfer [16].

4.8. Challenges to BCT Adoption

Several studies have highlighted and analyzed the challenges to BCT adoption by applying various frameworks. Apart from organizational and behavioral factors, the role of government, rules, and regulations has been studied to promote and impede the adoption of blockchain technologies, stressing its critical importance. While countries encourage digital transformation, they also prioritize data privacy regulations, such as the General Data Protection Regulation (GDPR), which mandates compliance from both nations and businesses [105].The essential variables identified in the research on the challenges for adoption of blockchain technology are described in Table 4.

Table 4. Challenges to Business Blockchain Technology Adoption.

Theories	References	Applied On	Challenges	Solutions
TOE framework (Organizational factors)	• [146] • [70,72,133] • [147] • [148,149].	• Educational institutions • Financial institutions • Manufacturing firms, • Government organizations	• Organizational innovativeness • Organizational learning capability • Standards uncertainty.	Prioritizing cost reduction, Improved security and new blockchain-enabled business models can promote wider blockchain adoption [102].
TOE framework (Environmental factors. Mainly industry pressure)	• [15,150,151] • [8] • [152] • [26]	• Logistics and supply chain • Agro-industry • Mining • Automotive	• Resistance from trading partners • Customer requirements	Awareness creation among stakeholders
TOE framework (Organization demography)	[58,138]	Various industries without classification	Lack of support for SMEs	Awareness creation and support of SMEs
Diffusion of Innovation	[29,57,145,153]	Analyzing diffusion across businesses in different industries without classification	• Low diffusion across industries, • High implementation costs, • Absence of legal structures	• Government support • Establishing legal frameworks • Promoting scientific literacy [145].
Technology acceptance model (Davis, 1989)	[58,59,67,126,154–156]	General user behavior across sectors	• Lack of trust and reliability • Lack of awareness	• Stakeholders, including governments, should collaborate to enhance security and trust in blockchain applications [156].

4.9. Framework Mapping

We constructed the following framework (displayed in Figure 5) based on the review in the earlier sections, which integrates the factors utilized in the literature on blockchain technology adoption by businesses.

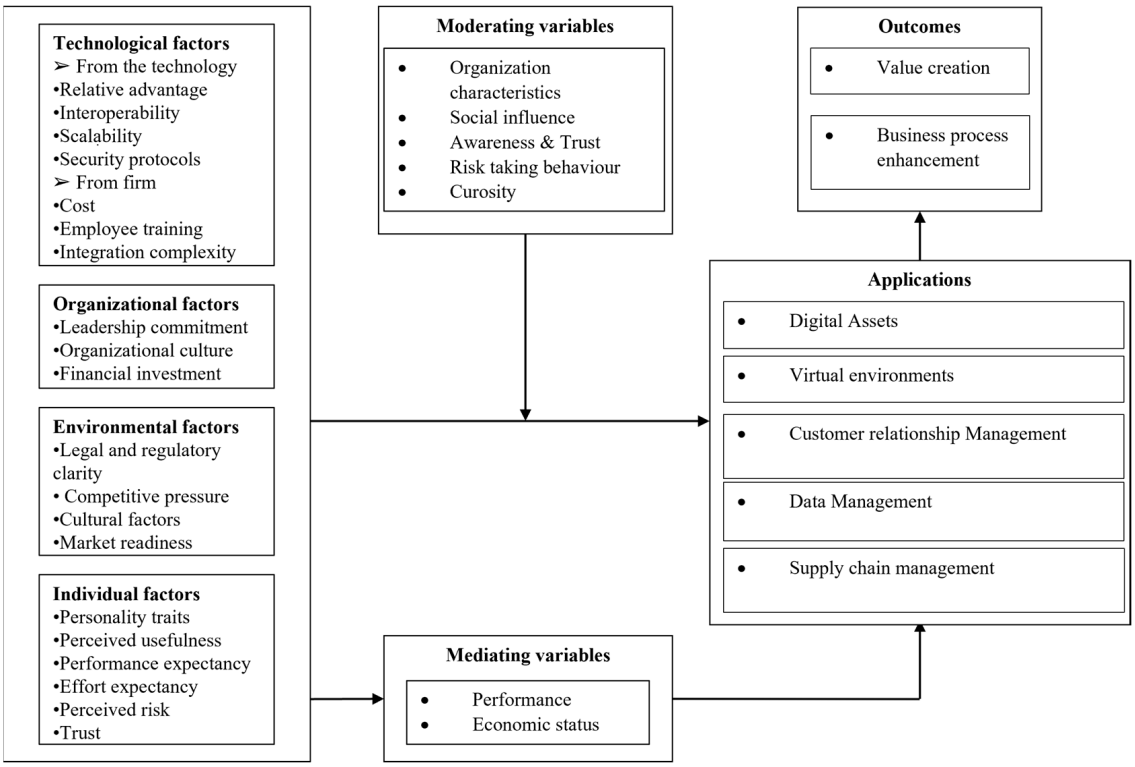

Figure 5. A conceptual framework for blockchain adoption by businesses.

The model was created using the technology, organization, and environment (TOE) framework. However, our literature review revealed that the adoption of blockchain technology involves individuals and stakeholders involved in the business process, which can potentially influence the adoption process, as well as their decision to adopt or not, and is affected by a range of different factors; thus, an individual dimension was included. Mediating and moderating variables are also considered.

We divided the technological elements into those that arise from the technology itself and those that stem from internal organizational factors, such as the availability of technical infrastructure. In the technology section, we mapped elements from the DOI (relative advantage) and TOE (characteristics of the technology), such as technology maturity, confidentiality, scalability speed, and security (network attack).

As indicated by the literature, the facilitating conditions are decentralized management [108,109]), immutability [110,111], data security [103], traceability [111,112], and enhanced transparency [38,93].

The organizational factors were mapped into two categories: organizational characteristics and organizational orientation. Organizational demographics, such as organization size, age, and industry, were not covered because the literature on blockchain adoption has received less attention. An organization's characteristics consist of its innovativeness, structure, expertise, and culture. Strategic orientation is, as described in the literature, a business approach to implementing blockchain technology for strategic purposes, such as retaining customers, improving the customers' experience, demonstrating social responsibility, sustainability, and progression towards Industry 4.0.

Individual factors include personal characteristics, such as personality types and traits, that influence how people relate to business and perceive and respond to blockchain

technology. From the behavioral technology adoption framework UTAUT, the factors performance expectancy and effort expectancy were identified; and from TAM, perceived usefulness and perceived ease of use were identified in the literature review. The identified recurring behaviors that impact perceived usefulness and ease of use the most were managers' awareness, managers' characteristics, such as risk-taking behavior, technological curiosity or learning, and the behavior of stakeholders, such as trust.

The literature extensively investigates environmental factors. Governance, stakeholder pressure, and industry pressure are all categorized as environmental factors. Industry pressure refers to external pressure stemming from sources such as competitor pressure and social pressure. Governance includes ecosystems, ethics, and legal processes (e.g., data protection regulations). Stakeholders consist of customers, suppliers, shareholders, employees, and other interest groups that can potentially influence the business's decision. Although several recurring applications were identified based on their similarity, we categorized them into two themes: supply chain management and data management, and their respective implications on the business's operations.

This integrative framework differs from other frameworks developed in the literature on blockchain technology adoption, which are industry-specific or cross-industry. Our integrative approach presents challenges for blockchain adoption among businesses, applications, and outcomes. We strategically identify the current study's constructs using bibliometric analysis and categorize them without being too generic.

5. Conclusions, Limitations, and Directions for Further Research

5.1. Conclusions

This study systematically reviewed the literature on blockchain technology adoption by businesses. First, we conducted a bibliometric analysis to understand current research trends, such as the core themes and recent advances. Second, an in-depth literature study was conducted to explore further the literature and broaden the information sources. This significantly contributed to the establishment of our conceptual framework on blockchain technology adoption by businesses, which explains the entire review. The following are some of the most important conclusions of this review:

Recent research on the implications of blockchain adoption has focused extensively on the factors that drive blockchain adoption by businesses and barriers to adoption. These studies combined various technology adoption models with other models, such as value creation and economic models. Several variables influence a business's adoption of blockchain, categorized as technological, organizational, individual, and environmental. Individual, technological, and environmental aspects were identified as the subjects of high investigation. However, prior research has paid minimal attention to organizational factors, such as power concentration, administrative procedures, hierarchical levels, human resource coordination, accessible resources, worker relationships, and firm age, which must be thoroughly investigated.

Business operations have been a primary consideration in the study of the role of blockchain adoption by businesses. Blockchain technology is primarily projected to benefit businesses by improving their business process efficiency; however, there has been a paradigm shift towards social responsibility, sustainability, and progression towards the fourth industrial revolution. Furthermore, value creation through technology research includes company performance, decision-making, strategy, and digitalization.

The supply chain has received much attention, but new growing themes and advances, including environmentally friendly supply chains, virtual environments, and digital identities are attracting interest. Furthermore, the integration of blockchain technology with other technologies, such as artificial intelligence (AI) and e-commerce, and its potential in extensive data management and the Internet of Things is investigated, implying a high emphasis on companies' attempts and interest in achieving automation and data exchange in manufacturing technologies and processes through the Fourth Industrial Revolution (Industry 4.0). Several technological, organizational, and environmental barriers have been

highlighted in the literature. Numerous studies have revealed that the government significantly affects blockchain adoption through regulations, such as human rights, innovation support, and stakeholder trust.

5.2. Limitations of This Study

This study has limitations, notwithstanding its efforts to provide insights into various literature on business blockchain adoption. First, the literature search was limited because it excluded review papers, refined items published only in English, and only analyzed articles from the Web of Science. This may have resulted in the exclusion of relevant literature and discoveries. Second, while utmost care was taken to choose a relevant set of search phrases, rapid improvements in blockchain technology have resulted in many advancements, which means that some may have been overlooked. Another limitation of this study is that attempts to replicate the analysis for 2024 may yield varying results due to the ongoing indexing process on the WOS platform. Moreover, some studies may be omitted and consequently missed in the thematic analysis, preventing their inclusion in this study. However, given the nature of this investigative process, we believe these limitations are reasonable and appropriate. Furthermore, future literature review studies may expand this work by considering these limitations.

5.3. Implications and Directions for Further Research

5.3.1. Implications of This Study

This research offers crucial knowledge for academics investigating recent developments and obstacles to the adoption and implementation of blockchain technology across various industries. The findings have important ramifications for decision-makers, organizations, and governmental bodies by emphasizing key thematic areas, including supply chain management, the Internet of Things, and e-commerce. Moreover, by identifying recent progress and proposing future research avenues, this study presents a blueprint for continued exploration in the field of blockchain technology. The thematic clusters discussed in this study shed light on the key challenges and opportunities in blockchain implementation for businesses. Regulators can leverage these findings to craft governance structures that tackle the juridical, technological, and socioeconomic hurdles associated with the adoption of blockchain.

Furthermore, technology developers play a vital role in constructing the necessary infrastructure and systems for an effective blockchain implementation. This research offers direction by identifying the technical obstacles that companies encounter and establishing a basis for developing innovative solutions that facilitate smooth blockchain adoption. Moreover, this study's conceptual framework for blockchain adoption by businesses summarizes its determinants, applications, and implications, displaying an overview in one frame. This allows for a clearer understanding of the existing state-of-the-art business blockchain applications. Furthermore, it can assist in determining where a gap exists in the literature and where important actions should be taken. In addition, the framework could be used to investigate BCT adoption in other contexts, such as by policymakers for voting and digital identity, as well as a variety of different applications, to better understand the implications of blockchain adoption on other features of social and individual behavior. It can also help assess and contrast the progress of other blockchain adoption studies.

The framework guides businesses to consider implementing BCT technology in a variety of ways. First, it assists in identifying the factors that influence adoption and its implications. Furthermore, it can affect a company's strategy and influence decisions by providing precise information on blockchain adoption barriers and outcomes. Another way is to aid businesses in establishing a solid basis for their BCT technology understanding, allowing them to adapt quickly and efficiently to their unique conditions.

5.3.2. Directions for Further Research

In this section, we present the gaps identified in this literature analysis. We address areas where current research is limited or completely lacking and highlight potential directions for future exploration.

Proposal 1. Decentralized finance risks and opportunities: Current research primarily emphasizes the advantages of blockchain, particularly in the realm of DeFi [157], While some studies touch on the regulatory challenges that DeFi faces [158], there remains a significant gap in fully examining both benefits and potential risks. Future research should explore the challenges posed by DeFi, particularly in terms of its security, regulatory compliance, and consumer protection. Conducting comparative studies across different regulatory regions, including the EU, U.S., and Asia, would clarify how these regulations affect the growth, adoption, and security of DeFi. This line of research could also shape policy frameworks that foster financial innovation while safeguarding against fraud and misuse.

Proposal 2. Blockchain for digital identity and self-sovereign identity systems: Blockchain's role in digital identity and self-sovereign identity (SSI) systems warrants further investigation [159,160]. Research on how SSI can reduce identity fraud and empower users to control their data could be invaluable, especially in critical areas, such as finance, public administration, and e-commerce, where identity verification is essential. Moreover, future studies should explore how SSI systems can be tailored to the unique needs of virtual environments, especially for identity portability across different platforms and environments.

Proposal 3. Blockchain in supply chain resilience and transparency: The previous literature indicated blockchain holds immense promise in terms of supply chain resilience and transparency. However, further studies are needed to explore their use in tracking perishable items, such as food and pharmaceuticals, and high-value goods, such as electronics and luxury items, for which authenticity and traceability are paramount [161,162]. Research in this area can address scalability and interoperability limitations that restrict the broader application of blockchain in complex, multi-stakeholder supply chains.

Proposal 4. Legal and regulatory frameworks for blockchain adoption: There is also a need to examine the legal and regulatory frameworks for blockchain adoption. Comparative studies across developed and developing nations can offer insights into how different legal landscapes influence blockchain innovation and adoption. Moreover, there is a need to explore how decentralized governance in virtual spaces aligns with regulatory requirements, particularly regarding content moderation, privacy, and user rights [163]. This understanding could help align regulatory approaches with technological advancements in various economic contexts.

Proposal 5. Blockchain in IoT and edge computing: The integration of blockchain with the IoT and edge computing also presents new research avenues. Studies assessing blockchain's ability to securely transfer and manage data in IoT networks could explore its role in industrial IoT applications, such as smart factories and connected vehicles, where data integrity and security are essential.

Proposal 6. Blockchain for digital public goods and humanitarian use: As the application of blockchain expands, there is an urgent need to explore the potential of blockchain to support digital public goods and humanitarian applications. Research into how governments and NGOs can leverage blockchain to deliver humanitarian aid, whether in disaster relief, public healthcare, or education, could reveal transformative benefits, enhance transparency, reduce corruption, and improve resource allocation in critical public sectors [164].

Proposal 7. Assess blockchain's impact and role in business innovation and on business performance: Although existing research highlights the potential benefits of blockchain, there is little consensus on how to measure its impact on business performance. Future research should conduct cross-sectional studies to measure empirically the effects of blockchain before and after its implementation. Blockchain has a significant potential for enhancing business innovation by enabling smoother stakeholder engagement and

value creation. Future studies should investigate how different types of organizations (e.g., resource-limited SMEs versus large firms) leverage blockchain to drive innovation.

Proposal 8. Cultural and socioeconomic impact on blockchain adoption: Cultural and socioeconomic factors influence blockchain adoption, particularly in developed, developing, and emerging economies. Future studies should analyze how these distinctions affect adoption decisions and the overall business processes.

Proposal 9. Distinguish between different blockchain system types: Current studies often overlook the differences between various blockchain systems and concepts; however, each offers unique benefits and faces distinct adoption barriers. Future research should classify blockchain types and examine how design differences affect their acceptance and diffusion.

Proposal 10. Prioritize longitudinal studies on adoption processes: To capture the dynamic nature of blockchain adoption better, longitudinal studies should focus on companies that have adopted or are planning to adopt blockchain applications. Examining adoption over time reveals how adoption barriers and drivers evolve across the phases. For instance, research can illustrate how interoperability needs and challenges change as blockchain networks mature and begin to interact across sectors.

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