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Review

A Systematic Review on Blockchain Adoption

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Abstract: Blockchain technologies have received considerable attention from academia and industry due to their distinctive characteristics, such as data integrity, security, decentralization, and reliability. However, their adoption rate is still scarce, which is one of the primary reasons behind conducting studies related to users' satisfaction and adoption. Determining what impacts the use and adoption of Blockchain technologies can efficiently address their adoption challenges. Hence, this systematic review aimed to review studies published on Blockchain technologies to offer a thorough understanding of what impacts their adoption and discuss the main challenges and opportunities across various sectors. From 902 studies collected, 30 empirical studies met the eligibility criteria and were thoroughly analyzed. The results confirmed that the technology acceptance model (TAM) and technology–organization–environment (TOE) were the most common models for studying Blockchain adoption. Apart from the core variables of these two models, the results indicated that trust, perceived cost, social influence, and facilitating conditions were the significant determinants influencing several Blockchain applications. The results also revealed that supply chain management is the main domain in which Blockchain applications were adopted. Further, the results indicated inadequate exposure to studying the actual use of Blockchain technologies and their continued use. It is also essential to report that existing studies have examined the adoption of Blockchain technologies from the lens of the organizational level, with little attention paid to the individual level. This review is believed to improve our understanding by revealing the full potential of Blockchain adoption and opening the door for further research opportunities.

Keywords: Blockchain; technology adoption theories; technology adoption models; systematic review

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1. Introduction

The creator of Bitcoin, Satoshi Nakamoto, proficiently described the Blockchain technology as a dispersed "peer-to-peer linked-structure" that could be used to resolve the apprehensions of maintaining the transaction order along with dodging double-spending issues [1]. With Bitcoin, transactions are commanded by grouping them into constrained-size structures called blocks, and a similar timestamp is shared between all blocks. In a Blockchain, miners such as network nodes connect the blocks preferably in chronological order, with each block containing a hash of the previous one [2]. Hence, the structure of a Blockchain often succeeds in holding an auditable and robust registry for all the related transactions. Any technology has its negative and positive sides. Negatively, Blockchain technologies have some disadvantages [3]. For example, Blockchains are harder to scale because of their consensus approach. Processing can be slow on Blockchains when many users exist on the network. Some solutions require high energy consumption. It's challenging to integrate Blockchains with several systems, specifically the legacy ones.

Positively, Blockchain technologies have brought many opportunities for various sectors. For instance, the banking sector can benefit from Blockchain to drive customer transactions under similar Blockchain standards. Blockchain allows for the transparent auditing of transactions. It is the case that different organizations have invested in this technology for a variety of reasons, such as reducing transaction costs and making architectures more transparent, safe, and quick. The significance of the Blockchain is demonstrated by the number of crypto-currencies, which have surpassed 1900 and are still growing [4]. This growth pace often creates interoperability problems due to the assortment of cryptocurrency-related applications [5,6]. Such a landscape is quickly evolving, as Blockchain is being applied in other fields outside of cryptocurrencies, where smart contracts play a primary role. Smart contracts are described as “a computerized transaction protocol that executes the terms of a contract” [7]. These contracts enable an individual to transform contractual clauses into embeddable code [8], consequently limiting the external risks and participation. Thus, a smart contract is an agreement between two parties where the agreed terms and conditions are automatically imposed even if the parties do not trust each other. As such, smart contracts in the context of Blockchains are scripts that run in a decentralized manner and are saved in the Blockchain without relying on third parties [9].

In healthcare, Blockchains can be used to reduce the communication and computational burden in data management [10]. This can be achieved through a secure transaction for a group of networks. Large amounts of healthcare data can also be managed using smart contract systems [11]. Additionally, linking medical devices to a Blockchain platform can connect patients, doctors, and providers to better understand who is complying with treatments and their consequences. In education, Blockchain applications can be used for certificate/degree verification, students’ assessments, credit transfer, data management, and admission purposes. Academic credential verification is essential for employers and other authorities to affirm the validity of an academic degree. Blockchain technologies allow students to access their official certificates under the protection and control of their universities [12].

The significance of Blockchain technology is increasing [13]. IBM added that around 33% of C-suite executives itemized that Blockchain is being discovered by them or were involved actively in the past projects [14]. The research and development community at large is already aware of the potential of upcoming technologies, along with discovering many different applications across a wide array of industries [9]. The development of Blockchain applications can be classified into three generations: (i) Blockchain 1.0 is used for cryptocurrency transactions, (ii) Blockchain 2.0 is used for financial applications, and (iii) Blockchain 3.0 is used for other industrial applications, such as government, health, science, and Internet of Things (IoT) [13].

Blockchain assists in tracing and verifying multistep transactions that require traceability and verification. Blockchains minimize compliance costs and accelerate data transfer processing. Perhaps the worthiest value of adopting Blockchains is the enhanced security provided to users while making transactions. This feature builds confidence between consumers and industry partners, protects privacy, and increases transparency in tracing transactions. Despite the tremendous opportunities of Blockchain technologies, their adoption across many domains is still in short supply [15]. Their low adoption rates stem from inadequate knowledge regarding the factors affecting their use [16]. To draw a holistic view of the factors affecting Blockchain adoption, we need to understand the theories/models through which these factors are derived. Understanding those factors through the lenses of these theories/models would help scholars and practitioners prepare future policies and procedures for effectively employing Blockchain technologies across various sectors. By inspecting the existing reviews on Blockchain, it has been observed that there is inadequate knowledge about the main research methods used in Blockchain adoption and the primary domains involving Blockchain applications. To understand these issues, this systematic review aimed to provide a holistic view of Blockchain adoption through the lenses of technology adoption theories and models, and to identify the main research gaps that would guide future research. Therefore, this review study poses the following research questions:

Q1: What are the main research methods and domains in the selected studies?

Q2: What are the main theories/models used for studying the use of Blockchain?
Q3: What are the most frequent external factors affecting the use of Blockchain?
Q4: What is the primary purpose of the reviewed studies?
Q5: Who are the target participants in the selected studies?

2. Related Work

Blockchain technology is a distributed ledger introduced for cryptocurrency in 2008 by Satoshi Nakamoto. In October 2008, Bitcoin was released [17]. In the second generation, smart contracts were introduced for assets and trust agreements. It was initiated by Ethereum, one of the most renowned Blockchain-based software platforms. The next wave of Blockchain technologies will focus on scaling and addressing transaction processing times and bottlenecking problems. There are three categories of Blockchains, including public, proprietary, and permissioned. As a public Blockchain, anyone can join, leave, contribute, read, and audit the Blockchain network, as it is decentralized, self-governed, and authority-free. Bitcoin represents an instance of public Blockchain. The private Blockchain, in contrast, is a closed network with a verified and authentic invitation that is only available for trusted and selected parties. This means only the Blockchain owner has the authority to edit, delete, or override entries on the Blockchain. The last type is referred to as permissioned Blockchain, which permits anyone to join after their identity is verified. Each individual is given specific permissions on the network to perform specific processes. In the supply chain, suppliers, for instance, could manage a permissioned Blockchain for their business partners and customers with different access rights. On the other hand, customers can only be allowed to read product documents, whereas wholesalers and suppliers have access to edit information about the goods and delivery.

Due to its intrinsic characteristics in maintaining transaction transparency across various entities, Blockchain has received much attention from different industries. The primary example is the use of cryptocurrencies in finance [18,19]. Further, pharmaceutical, transportation, origin-to-consumer, legal, and regulatory areas are other non-financial domains that have witnessed prompt adoption and use of Blockchain applications [20]. Moreover, other applications have emerged regarding the use of Blockchain in the healthcare industry [21,22], the chemical industry [23], and big data [24]. Blockchain technology is viewed as a significant component of the fourth industrial revolution that has facilitated changing the structure of the global economy and enhancing the opportunities for innovation, development, and improved quality of life. Furthermore, a Blockchain-based digital government often streamlines processes, protects data, and reduces abuse and fraud while instantaneously boosting accountability and trust. Governments, businesses, and individuals share resources through a distributed ledger protected by cryptography. By eliminating single points of failure, it protects governments and citizen data.

A synthesis of the previously published reviews was performed to understand the current state-of-the-art of Blockchain technologies. Table 1 shows the earlier review studies conducted on Blockchain technology. This subject has recently gained extensive international interest and attention. It can be noticed that Blockchain technology has been studied across several disciplines, including energy, healthcare, agriculture, education, logistics, and supply chain management. Some reviews have examined the underlying Blockchain technology, such as cryptography, peer-to-peer networking, distributed storage, consensus algorithms, and smart contracts [25–27]. Other reviews were interested in highlighting the laws and regulations governing this technology [28]. Some of the reviews focused on the educational applications built using Blockchain technologies, their benefits, and the obstacles to implementation [29]. Another review identified organizational theories and discussed their application in adopting Blockchain technologies in logistics and supply chain management [30]. It can be observed that the existing reviews have neglected to review the factors affecting Blockchain adoption from the perspective of technology adoption theories/models. In addition, there is insufficient knowledge about the main research methods used in Blockchain adoption and the primary domains involving Blockchain applications. Therefore, this systematic review aimed to provide a comprehensive review of Blockchain adoption by examining the main research methods, domains, technology acceptance models/theories, influential factors, research objectives, and target participants.

Table 1. Previous review studies on Blockchain technologies.

Source	Review Type	Number of Reviewed Studies	Domain	Aim
[31]	Systematic review	65 studies	Healthcare	To review the use of Blockchain technology in healthcare.
[25]	Systematic review	140 studies	Energy	To review and examine the basic ideas that drive Blockchain technology, such as systems design and distributed consensus methods. It also concentrated on Blockchain solutions for the energy industry and enlightened the state-of-the-art issues by extensively analyzing the literature and existing business cases.
[32]	Systematic review	33 studies	Healthcare	To demonstrate the potential use of Blockchain technologies, their obstacles, and future research directions in healthcare.
[33]	Systematic review	27 studies	Supply chain management	To explain the most common Blockchain applications in supply chain management (SCM). It also covered the critical disruptions and problems resulting from Blockchain adoption in SCM, and how the future of Blockchains in SCM holds.
[29]	Systematic review	31 studies	Education	To review the applications of Blockchain in education and provide an insight into the main benefits and obstacles of implementation.
[28]	Systematic review	29 studies	Supply chain	To evaluate how Blockchain technologies would affect supply chain practices and policies in the future.
[26]	Systematic review	61 studies	Healthcare	To review the prototypes, frameworks, and implementations of Blockchain in healthcare.
[34]	Systematic review	10 studies	Agriculture	To review current research subjects, significant contributions, and benefits of using Blockchain technologies in agriculture.
[30]	Systematic review	22 studies	Logistics and supply chain management	To identify the most relevant organizational theories used in Blockchain literature in the context of logistics and supply chain management (LSCM). It also examined the content of those organizational theories to formulate relevant research questions for investigating the adoption of Blockchain technologies in LSCM.
[35]	Review	-	General (not specific to a particular domain)	To examine the Blockchain and its related essential features, concerns (IoT, security, and data management), and industrial applications. It also provides potential difficulties and future directions.
[36]	Systematic review	42 studies	Healthcare	To figure out how Blockchain technologies can be used in the healthcare domain.
[37]	Systematic review	35 studies	Governance	To provide scholars and practitioners with directions on using Blockchain applications in governance research.
[38]	Systematic review	32 studies	General (not specific to a particular domain)	To offer the most recent state of research on the potential combination of AI and Blockchain technologies and discuss the possible advantages of such a combination.
[39]	Review	-	Supply chain and logistics	To explain and describe the idea of Blockchain and its use in logistics and supply chains.
[40]	Systematic review	35 studies	IoT	To evaluate academic solutions and approaches of integrating Blockchain with IoT.
[41]	Review	-	General (not specific to a particular domain)	To discuss the fundamentals of Blockchain technologies and their technical details.
This study	Systematic review	30 studies	General (not specific to a particular domain)	To provide a thorough review of Blockchain adoption by examining the main research methods, domains, technology acceptance models/theories, influential factors, research objectives, and target participants.

3. Materials and Methods

This study applied the systematic review approach to review the existing studies on Blockchain adoption. This approach uncovers sources relevant to a research topic and provides a rich synthesis of the subject under examination. This research follows the systematic review guiding principles introduced by Kitchenham and Charters [42] and other related systematic reviews [43–45]. The following subsections detail the phases followed during the review process.

3.1. Inclusion and Exclusion Criteria

Table 2 lists the inclusion and exclusion criteria for the publications that were critically evaluated in this review.

Table 2. Inclusion and exclusion criteria.

Inclusion Criteria	Exclusion Criteria
Should be published between 2010 and 2021.	Studies involving Blockchain but without a theoretical model.
Should involve a theoretical model for evaluating Blockchain.	Studies involving a theoretical model but without a Blockchain.
Should measure the adoption, acceptance, or continued use of Blockchain.	Studies written in languages other than English.
Should be written in English language.	

3.2. Data Sources and Search Strategies

In this systematic review, the surveyed articles were collected from a wide range of online databases, including Emerald, IEEE, ScienceDirect, Springer, MDPI, and Google Scholar. The search for these studies was undertaken in April 2021. The keywords used in the search include ((“Blockchain”) AND (“adoption” OR “acceptance” OR “use” OR “intention to use” OR “continued use” OR “continuous intention”)). Choosing the keywords is essential since it determines which articles are to be retrieved [46]. Using the above search strategies, the search results retrieved 902 articles. Of those, 218 were marked as duplicates, so we removed them from the analysis. Thus, the overall number of the remaining articles becomes 684. We have applied the inclusion and exclusion criteria for each of these studies. Accordingly, 30 studies met these criteria and were kept for the final analysis. The search and refinement stages were carried out using the “Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)” [47]. Figure 1 shows the PRISMA flow diagram.

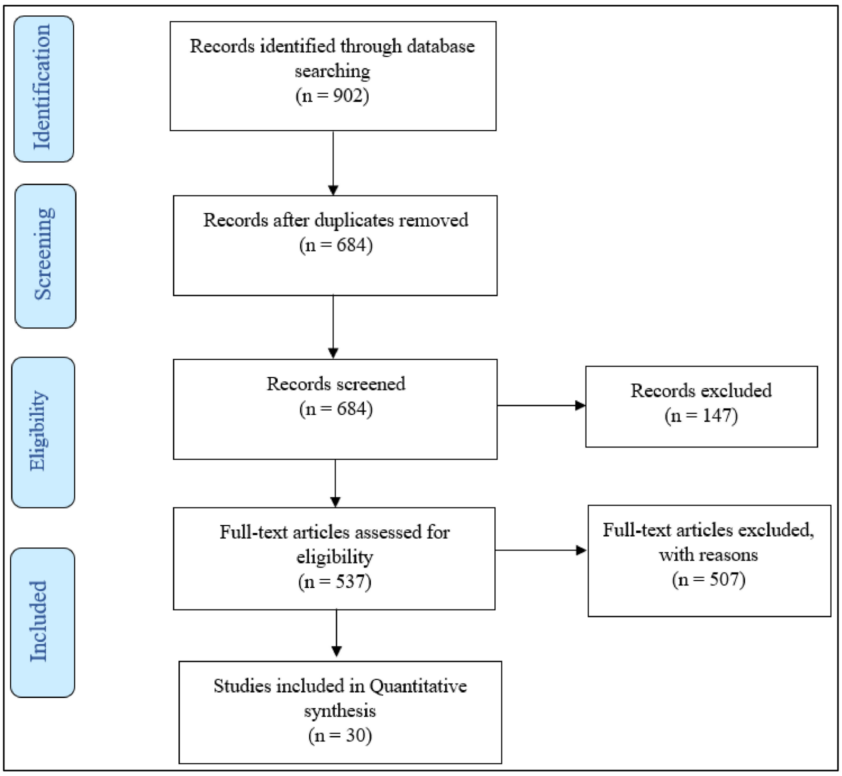

Figure 1. PRISMA flowchart.

3.3. Quality Assessment

Along with the inclusion and exclusion criteria, quality assessment is another crucial factor to consider [48]. A nine-criteria checklist was adopted from Alqudah et al. [49] and Al-Emran et al. [48] as a quality assessment and used to provide a method for evaluating the quality of the research papers that were kept for the final analysis (n = 30). Table 3 illustrates the quality assessment checklist. The primary purpose of the checklist was not to criticize any scholar's work, and the checklist was adapted from those suggested by Kitchenham and Charters [42]. Each question in the checklist was scored according to the three-point scale, an answer of "Yes" being worth 1 point, an answer of "No" being worth 0 points, and an answer of "Partially" being worth 0.5 points. Therefore, each study could receive an accumulated score between 0 and 9. The higher the total scores a study attained, the higher the degree to which the study addressed the research questions. This was ensured by assessing each study against the nine quality assessment criteria. For each study, the first and second authors assigned scores to the nine quality assessment criteria independently to ensure accuracy. Differences in assigning scores between the two authors were resolved through discussion and further review of the disputed articles. Table 4 presents the quality assessment results of all 30 studies. It is evident that all studies passed the quality assessment, and they were eligible for final analysis.

Table 3. Quality assessment checklist.

#	Questions
1	Is the research aim specified clearly?
2	Did the study achieve its aim?
3	Are the variables considered by the study clearly indicated?
4	Is the context/discipline of the study clearly defined?
5	Are the data collection methods sufficiently detailed?
6	Are the measures' reliability and validity clearly described?
7	Are the statistical techniques used to analyze the data sufficiently described?
8	Do the findings add to the literature?
9	Does the study add to your knowledge or understanding?

Table 4. Quality assessment results.

Study	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Total	Percentage
S1	1	1	1	0.5	1	1	1	1	1	8.5	94.44%
S2	1	1	1	1	1	1	1	1	1	9	100%
S3	1	0.5	1	1	1	1	1	0.5	0.5	7.5	83.33%
S4	1	1	1	1	1	1	1	1	1	9	100%
S5	1	0.5	1	1	1	1	1	0.5	0.5	7.5	83.33%
S6	1	1	1	1	1	1	1	1	1	9	100%
S7	1	1	1	1	0	1	0	1	0.5	6.5	72.22%
S8	1	0.5	1	0.5	1	0.5	1	0.5	0.5	6.5	72.22%
S9	1	1	1	1	1	1	1	1	1	9	100%
S10	1	1	1	1	1	1	1	1	0.5	8.5	94.44%
S11	1	1	0.5	0.5	0.5	0.5	0.5	1	0.5	6	66.66%
S12	1	1	1	1	1	1	1	1	1	9	100%
S13	1	1	1	1	1	1	1	1	1	9	100%
S14	1	1	1	1	0	0.5	0	1	0.5	6	66.66%
S15	1	1	1	1	1	1	1	1	1	9	100%
S16	1	1	1	1	1	1	0.5	1	1	8.5	94.44%
S17	1	1	1	1	1	1	1	1	1	9	100%
S18	1	1	1	1	1	1	1	1	1	9	100%
S19	1	1	1	1	1	0.5	0.5	1	1	8	88.88%
S20	1	1	1	1	1	1	1	1	1	9	100%
S21	1	0.5	1	1	1	0.5	1	0.5	1	7.5	83.33%
S22	1	1	1	1	1	1	1	1	1	9	100%
S23	1	1	1	1	0.5	1	0.5	1	1	8	88.88%
S24	1	1	1	1	1	1	1	1	1	9	100%
S25	1	1	1	1	0.5	1	1	1	1	8.5	94.44%
S26	1	1	1	1	1	1	1	1	1	9	100%
S27	1	1	1	1	1	1	0.5	1	0.5	8	88.88%
S28	1	1	1	1	0.5	1	1	1	1	8.5	94.44%
S29	1	1	1	1	1	1	0.5	1	1	8.5	94.44%
S30	1	1	1	1	0.5	1	1	1	1	8.5	94.44%

3.4. Data Coding and Analysis

For the sake of answering the research questions of this review, we have coded the final list of the remaining articles (*n* = 30) based on several characteristics, including authors, publication year, methods, countries, factors, domains, theories/models, research aims, and participants.

4. Results

Drawing upon the 30 research studies analyzed in this systematic review, we have reported the findings to answer the formulated research questions. Table A1 (Appendix A) provides a brief description of all the analyzed studies.

4.1. Main Research Methods

Figure 2 depicts the distribution of studies according to the research method used in data collection. It is evident that questionnaire surveys represent the primary research method used in 77% of the analyzed Blockchain adoption studies. However, only 10% of the Blockchain adoption studies relied on interviews in collecting their data.

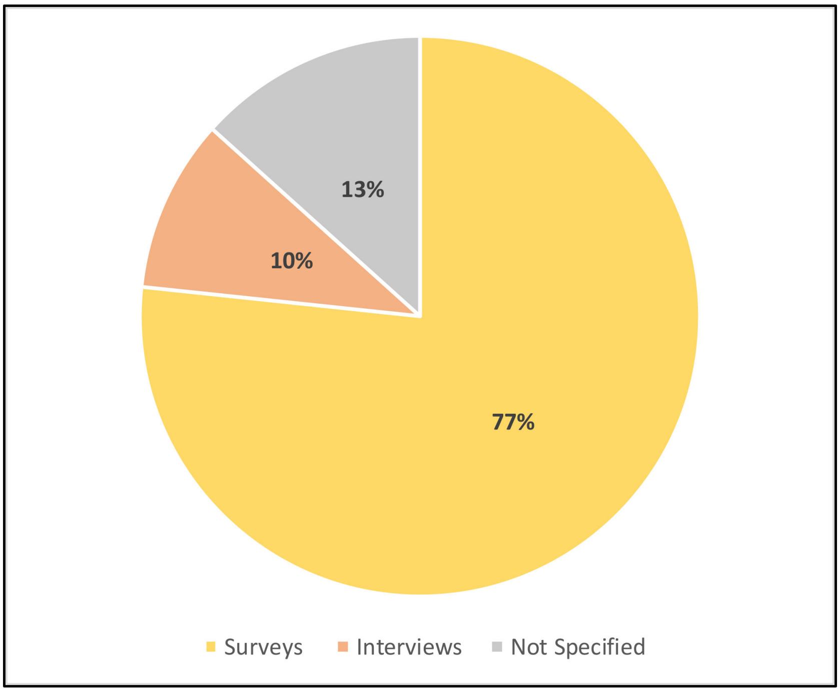

Figure 2. Distribution of studies by research methods.

4.2. Main Domains

Blockchain applications have been extensively used across many domains/sectors. The collected studies were analyzed according to these domains/sectors to provide an overview of the current status of Blockchain applications. Figure 3 depicts the main domains/sectors in which Blockchain applications were adopted. It can be seen that supply chain management dominates the list, with 12 studies. This is followed by education and agriculture, with three studies each. In the supply chain, organizations can automate physical assets and create a decentralized steady record of all transactions, making it possible to track assets from production to delivery or use by end-users. Other applications include maritime shipping [50], organizing decisions [51], and executing operations [52].

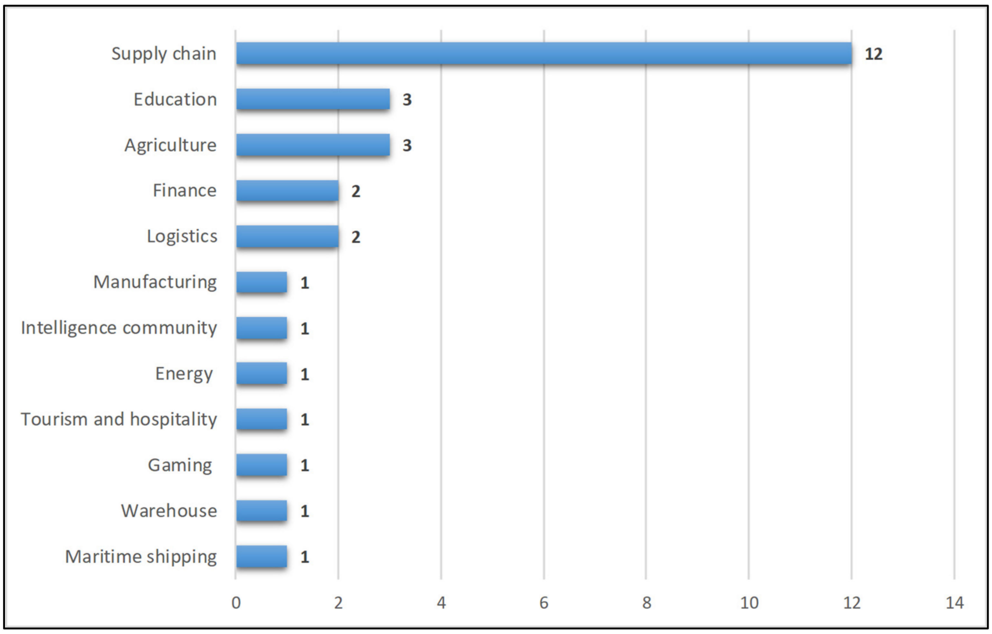

Figure 3. Main domains in Blockchain adoption.

4.3. Prevailing Theories/Models in Blockchain Adoption

As we aimed to examine the adoption of Blockchain technologies, the collected articles were analyzed from the perspective of technology adoption theories/models, as shown in Figure 4. It can be seen that the "technology acceptance model (TAM)" is the most common model in studying Blockchain adoption, with 14 studies. This is followed by the "technology-organization-environment (TOE)" (n = 8), "unified theory of acceptance and use of technology (UTAUT)" (n = 7), and "innovation diffusion theory (IDT)" (n = 5). The rest of the theories/models appeared only once in the examined studies (i.e., TRI2, ISS, TTF, TPB, TRA, and TAM3).

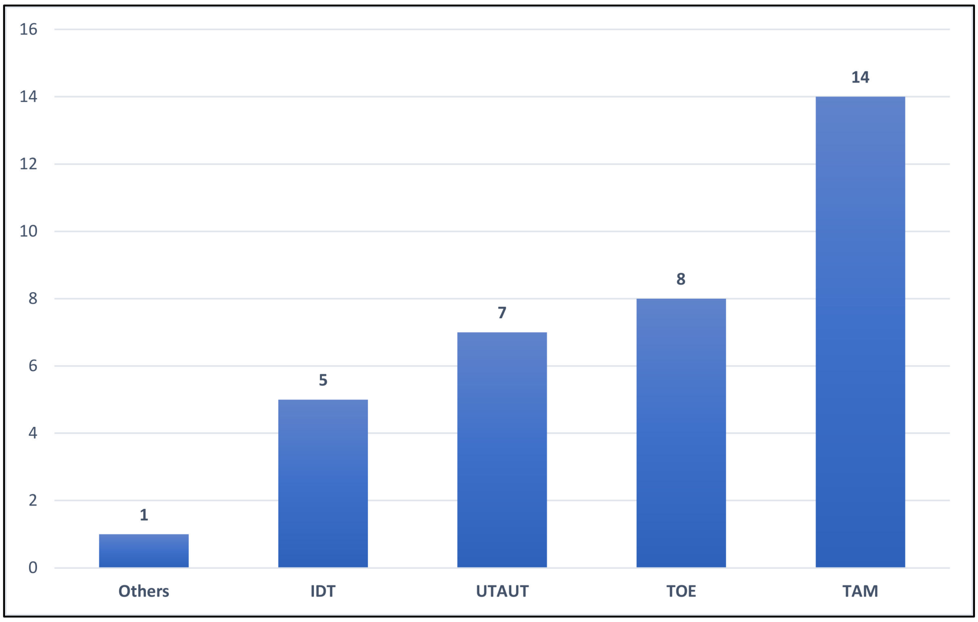

Figure 4. Distribution of studies by technology adoption models/theories.

4.4. Most Frequent External Factors Affecting the Use of Blockchain

The low adoption rates of many technologies, with no exceptions to Blockchain, stem from the inadequate knowledge regarding the factors affecting their use. Therefore, we have analyzed the collected studies to identify the most common external factors affecting the adoption of Blockchain technologies, as shown in Figure 5. Trust appeared to be the most common factor affecting the adoption of Blockchain technologies (n = 17). This is followed by the perceived cost and social influence with 11 studies each, then by facilitating conditions (n = 10), performance expectancy, effort expectancy, and information security, with seven studies each.

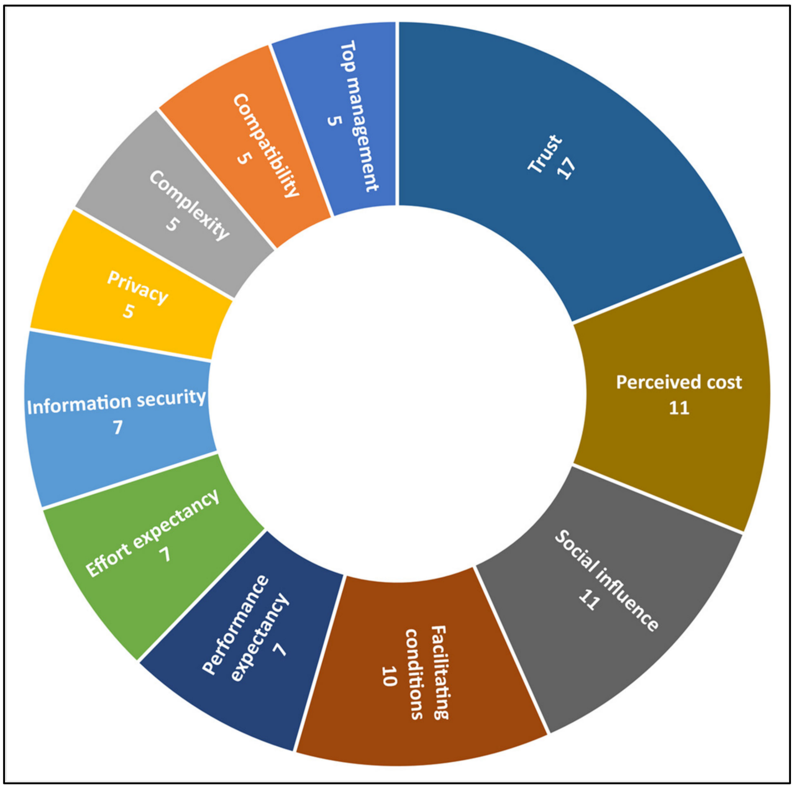

Figure 5. Most common external factors affecting Blockchain adoption.

Apart from the collected studies, we have also analyzed the existing literature on Blockchain to determine the barriers affecting its adoption. Security risk [53,54] and privacy risk [53,55,56] were among the main risks that negatively affect the use of Blockchain technologies. High energy costs [53,54,57] and investment costs [58–60] represent the main costs of using Blockchain technologies. Organizations also impose some barriers to using Blockchain technologies, such as organizational policies [61–63], organizational culture [55,61,64,65], lack of knowledge and management support [63,65,66], and lack of collaboration and coordination [63,64,67]. It is also imperative to mention that adopting Blockchain is hindered by some technological barriers, such as technological immaturity [53,54,65], reluctance to change [60,68,69], interoperability issues [60,63,65,70,71], and scalability issues [53,56,63]. Cultural differences [61,64,72] are also considered a barrier to Blockchain adoption. This is mainly because users rely on themselves when seeking advice related to using Blockchains in individualistic societies, while they rely on others in collectivistic cultures.

4.5. Primary Purpose of the Reviewed Studies

There are three different concepts within the technology adoption domain, including adoption, acceptance, and post-adoption/continuous intention. The adoption is usually measured by potential users who have not yet used the technology, whereas actual users measure the acceptance. The post-adoption/continuous intention measures the continued use of the technology after a sufficient period of users' experience. It is essential to understand the purpose of the analyzed studies concerning the previously mentioned concepts to understand where we stand on Blockchain adoption. It has been noticed that 80% of the analyzed studies concentrated on measuring Blockchain adoption, followed by 10% for both acceptance and continuous intention.

4.6. Target Participants in the Selected Studies

To understand who evaluated the use of Blockchain technologies, we have classified the analyzed studies in terms of participants, as depicted in Figure 6. Fifty percent of the analyzed studies relied on the top management to evaluate the use of Blockchain technologies. This was followed by experts and consultants (28%), academics (13%), and students (5%).

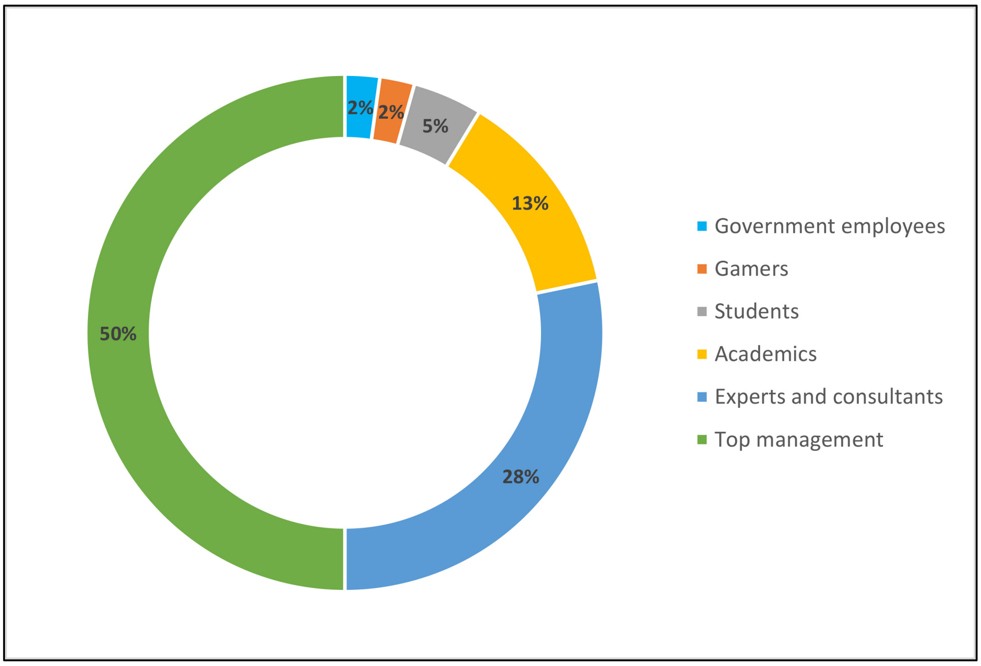

Figure 6. Distribution of studies by participants.

5. Discussion

It is imperative to understand what impacts the adoption of new technologies, such as Blockchain. Adopting any technology relies on the determinants affecting its users [73–75]. A forecasting report illustrates the positive evolution of the Blockchain market between 2017 and 2024 [76]. While this magnitude was USD 800 million in 2017, it is estimated to reach USD 20,550 million in 2024. Therefore, it is vital to gain more insights into what impacts the adoption of Blockchain technologies across many sectors to improve and sustain their usage. Hence, this systematic review was carried out to analyze the adoption of Blockchain technologies from the lenses of technology adoption theories/models.

The results showed that questionnaire surveys represent the primary research method used in 77% of the analyzed Blockchain adoption studies. These outcomes agree with some of the earlier systematic reviews in the technology adoption domain [77–80], which concluded that questionnaire surveys were the most common data collection method. In terms of the Blockchain, these results contradict what Frizzo-Barker et al. [81] reported, in which comparative studies were the primary method used in most of the analyzed articles. Drawing upon the findings of this systematic review, it is suggested that further research would consider the mixed-research approach by involving interviews or focus groups besides using questionnaire surveys. This is because qualitative approaches provide more insights into the cause–effect relationships among the factors affecting Blockchain adoption.

Regarding the main domains/sectors through which the analyzed studies were carried out, supply chain management dominates the list with 12 studies, followed by education and agriculture, with three studies each. While our findings agree with [82], who found that supply chain management is the dominating sector concerning studies related to Blockchain adoption, it contradicts what is reported by [81], who suggested that banking and finance was the primary sector. Regardless of the differences between this review and the previously conducted reviews, understanding Blockchain adoption across many domains is still in short supply due to the limited number of applications.

Concerning the prevailing technology adoption theories/models, the results pointed out that the TAM is the most common model in studying Blockchain adoption, with 14 studies. This is followed by the TOE (n = 8), UTAUT (n = 7), and IDT (n = 5). In the same vein, Taherdoost [82] found that TAM and TOE were the most dominating models in studying Blockchain adoption. TAM is still a valid model to evaluate large-scale emerging technologies [83,84], where Blockchain is not an exception. These results indicate that studies focusing on the individual level have mainly relied on TAM, while those examining the organizational level have relied on TOE. Further research might consider other adoption models that have yet to be used in the existing literature, such as UTAUT2, ECM, PMT, etc.

For the influential factors affecting Blockchain adoption, trust was seen to be the most common factor affecting the adoption of Blockchain technologies (n = 17). This was followed by the perceived cost and social influence, with 11 studies each, as well as facilitating conditions (n = 10), performance expectancy, effort expectancy, and information security, with seven studies each. Studies on the individual level have examined trust, social influence, performance expectancy, effort expectancy, and information security. In contrast, those focusing on the organizational level studied mainly the organizational perspective's factors in delivering Blockchain-based services, such as trust, perceived cost, and facilitating conditions. Still, there is abundant room for other factors to be investigated from the perspective of other technology adoption theories/models and Blockchain-related specific characteristics. On the other side, we have also analyzed the existing literature on Blockchain to determine the barriers affecting its adoption. Being aware of these barriers and considering them when implementing Blockchains would improve their adoption rate. Security risk and privacy risk were among the main risks that negatively affect the use of Blockchain technologies. High energy and investment costs represent the main costs of using Blockchain technologies. Organizations also impose some barriers to using Blockchain technologies, such as organizational policies, organizational culture, lack of knowledge and management support, and lack of collaboration and coordination. It is also imperative to mention that adopting Blockchain is hindered by some technological barriers, such as technological immaturity, reluctance to change, interoperability issues, and scalability issues. Cultural differences are also considered a barrier to Blockchain adoption. This is mainly because users rely on themselves when seeking advice related to using Blockchains in individualistic societies, while they rely on others in collectivistic cultures.

To understand the primary purpose of the analyzed studies, the results showed that 80% of those studies concentrated on measuring Blockchain adoption, followed by 10% for both acceptance and continuous intention. These results clearly indicate that the majority of existing studies have examined the adoption stage of Blockchain technologies, the step that precedes the actual use of the technology. The results provided evidence that there is inadequate exposure to studying the actual use of Blockchain technologies and their continued use, which furnish a good space for further research.

The results reported that 50% of the analyzed studies relied on the top management to evaluate the use of Blockchain technologies, followed by experts and consultants (28%), academics (13%), and students (5%). This shows that most of the existing studies have examined the adoption of Blockchain technologies from the lens of the organizational level, with little attention paid to the individual level.

This systematic review differs from previous reviews in several ways. This review did not limit the data collection to a specific domain, while most of the earlier reviews did. Most of the earlier reviews concentrated on using Blockchain applications in healthcare [26,31,32,36] and supply chain and logistics [28,30,33,39]. While some of the previously conducted reviews were general in the domain, their aims and scope were entirely different from the current study. For instance, Lu [35] investigated the Blockchain and its essential features, concerns (IoT, security, and data management), and industrial applications. Karger [38] offered the most recent research on the potential combination of AI and Blockchain technologies and discussed the possible advantages of such a combination. Besides, Namasudra et al. [41] discussed the fundamentals of Blockchain technologies and their technical details. To make it distinct, this systematic review provided a thorough review of Blockchain adoption by examining the main research methods, domains, influential factors, research objectives, and target participants through the lenses of technology acceptance models/theories.

6. Conclusions and Future Work

Despite the immense opportunities of Blockchain technologies, their adoption across many domains is still in short supply [15]. This is one of the main reasons behind conducting studies related to users' satisfaction and adoption. Determining what impacts the use and adoption of Blockchain technologies can efficiently address their adoption challenges. Therefore, we have reviewed the Blockchain adoption studies from the perspective of technology adoption theories/models to identify the most influential factors, main research methods, domains/sectors, research objectives, and target participants. It is believed that this systematic review would be a valuable guide for scholars and practitioners seeking to understand the challenges and opportunities related to the adoption of Blockchain technologies across various sectors.

This review shed light on several gaps in research. First, the TAM and TOE were the most common models for understanding the factors affecting the use and adoption of Blockchain technologies. Little attention has been paid to the role of technical, social, and psychological elements in understanding the adoption of Blockchain applications. This gap requires further research by considering other adoption theories/models such as UTAUT2, ECM, PMT, etc. Second, although Blockchain adoption is still in short supply, the findings showed that supply chain management was the dominating sector among others in the examined studies. We found a dearth of empirical research in the other domains, which necessitates the need for future research to look at how Blockchain technologies are adopted. Third, trust, perceived cost, and social influence were the most common factors affecting the adoption of Blockchain technologies. The other factors were mainly adapted from the most common theories, such as TAM and TOE. By involving other theories/models, understanding what impacts the use and adoption of Blockchain technologies would be enlightened, specifically when the factors are related to Blockchain-specific characteristics.

Fourth, 77% of the analyzed Blockchain adoption studies relied on questionnaire surveys for data collection. Hence, it is suggested that further research would consider the mixed-research approach by involving interviews or focus groups, besides using questionnaire surveys. This is because qualitative methods can explain the interrelationships among the factors affecting the adoption of Blockchain. Fifth, unlike the previous systematic reviews that analyzed conceptual and empirical studies, it is imperative to mention that this review has concentrated only on empirical Blockchain studies. Since there is still a limited number of studies across the world, more empirical research is required to examine the users' maturity levels and capabilities of adopting Blockchain applications across many collectivistic and individualistic societies. The implications of Blockchain applications, with their negative or positive sides, in certain cultural environments would assist in developing these applications both socially and economically.

Sixth, the findings showed that 80% of the examined studies concentrated on measuring Blockchain adoption, with a limited number of studies focusing on the acceptance and continuous intention perspectives. There is insufficient knowledge of what impacts the actual use of Blockchain technologies and their continued use, which opens the door for further research trials. Seventh, 50% of the analyzed studies relied on the top management, experts, and consultants to evaluate the use of Blockchain technologies. This shows that most of the existing studies have examined the adoption of Blockchain technologies from the organizational level perspective, with little attention paid to the individual level.

This review is limited in two ways. First, we focused on specific online databases to collect articles, such as Emerald, IEEE, ScienceDirect, Springer, MDPI, and Google Scholar. However, these online databases do not represent the entire literature published on Blockchain adoption. Further reviews might thus extend this review by involving studies indexed in other databases, such as Scopus and Web of Science. Second, this systematic review involved analyzing only empirical quantitative studies. Considering qualitative studies in future reviews would add more insights into the observed results.

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Appendix A

Table A1. List of analyzed studies.

#	Source	Year	Method	Country	Domain	Theories/Models
S1	[85]	2020	Survey	Not specified	Finance	TAM
S2	[51]	2021	Survey	India	Supply chain management	TAM and TOE
S3	[52]	2020	Survey	Malaysia	Supply chain management	TOE
S4	[86]	2020	Survey	India	Supply chain management	TAM and IDT
S5	[87]	2020	Survey	India	Agriculture supply chain	ISM-DEMATEL
S6	[50]	2019	Survey and interviews	Taiwan	Maritime shipping	TAM
S7	[88]	2020	Not specified	Malaysia	Warehouse industry	UTAUT
S8	[89]	2020	Survey	Nigeria	Logistics	TOE
S9	[90]	2019	Survey	Brazil	Supply chain management	UTAUT
S10	[91]	2019	Survey	Indonesia	Gaming	TAM
S11	[92]	2017	Survey	Taiwan	Finance	IDT and TAM
S12	[93]	2019	Survey	USA	Academia	UTAUT
S13	[94]	2019	Survey	USA and India	Logistics and supply chain management	TAM and UTAUT
S14	[95]	2018	Not specified	Not specified	Supply chain management	UTAUT
S15	[96]	2021	Survey	Kenya	Finance	TAM and IDT
S16	[97]	2019	Survey	Canada	Research community	TAM

Table A1. *Cont.*

#	Source	Year	Method	Country	Domain	Theories/Models
S17	[98]	2019	Survey	Taiwan	Tourism and hospitality	TAM
S18	[99]	2020	Survey	Developed countries	Energy	TAM and DOI
S19	[100]	2021	Survey	Malaysia	Education	TAM and DOI
S20	[101]	2020	Survey	Malaysia	Intelligence community	TAM 3 and TRI 2
S21	[102]	2021	Semi-structured interviews	Middle East and North Africa	N/A	DOI and TOE
S22	[103]	2021	Survey	India	Agri-food supply chain	ISM and DEMATEL
S23	[61]	2021	Survey	Not specified	Supply chain management	TOE
S24	[104]	2021	Survey	Malaysia	Manufacturing	TOE
S25	[105]	2021	Survey	Australia	Supply chain management	UTAUT, TTF, and ISS
S26	[106]	2018	Survey	India	Supply chain management	TAM, TRI, and TPB
S27	[17]	2019	Interviews	Ireland	Mixed contexts	TOE
S28	[107]	2020	Not specified	Not specified	Finance	TAM
S29	[108]	2020	Survey	Brazil	Supply chain management	UTAUT
S30	[109]	2020	Case study	Indonesia	Agriculture	TOE and the theory of mindfulness of adoption

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