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A Critical Literature Review on Blockchain Technology Adoption in Supply Chains

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Abstract: Inspired by the discontinuation of the blockchain platform TradeLens, co-developed by IBM and Maersk, due to the lack of the involved supply chain stakeholders' adoption, a critical literature review on the models of supply chain stakeholders' adoption of blockchain applications was conducted. This review is significant as it provides insights into the exploration of a more universal approach to investigate which factors really influence blockchain adoption, which is a pre-requisite for the technical sustainability of blockchain technology in supply chains. As observed in the review, the technology acceptance model (TAM), the technology–organization–environment (TOE) framework, and the unified theory of acceptance and use of technology (UTAUT) are frequently used in the literature, but little attention has been paid to whether blockchain technology fits the users' tasks in understanding blockchain adoption in the supply chain. Among the technology adoption theories, task–technology fit (TTF) considers whether a technology fits the tasks, but only two previous studies involved the use of TTF. This study discusses the suitability of these existing models of technology adoption for blockchain applications in supply chains and comes up with a new unified model, namely TOE-TTF-UTAUT. This review also has implications for a more appropriate conceptual research design using mixed methods.

Keywords: blockchain; technology adoption; supply chain management; technical sustainability; mixed methods

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1. Introduction

Supply chain management covers cumbersome processes as it involves tremendous transactions, information and document flows, currency exchange, logistics, and supply chain activities that require collaboration among supply chain stakeholders (e.g., suppliers, insurance companies, banks, forwarders, and customers) [1]. In these regards, secure transmissions, tracking of goods and services, information sharing, and trust among the supply chain stakeholders are important in supply chain management. Blockchain technology, which was initially created for the cryptocurrency Bitcoin in 2008 [2], has been applied to supply chain management to ensure secure transactions, product tracking, information sharing, and trust building among supply chain stakeholders [3].

The initial blockchain for Bitcoin is categorized as permissionless (or public) blockchain which is open to all, decentralized, transparent, and anonymous. With the decentralization feature, replicas of transactional records are distributed and shared among the parties involved in the transactions without control and administration by a central authority in the blockchain network. With the transparency feature, immutable transactional records stored in the blockchain are accessible by the public and validated through the consensus mechanism by the parties maintaining the blockchain. The anonymity feature prevents disclosure of the blockchain users' identities through cryptographically derived addresses.

Since the launch of the Hyperledger Project in December 2015, an infrastructure for permissioned (or private) blockchain referred to as Hyperledger Fabric has been developed. In contrast with permissionless blockchain, a permissioned blockchain is closed with accessibility control. Only the designated parties approved by the blockchain consortium can join the permissioned blockchain network, execute transactions, and access the transactional records stored in the blockchain. The permissioned blockchain is partially decentralized as it allows replicas of transactional records to be maintained by the members of the blockchain consortium. The blockchain consortium can decide whether the blockchain users can remain anonymous and decide whether the public can access the transactional records stored in the blockchain. These features of the permissioned blockchain facilitate supply chain management. In this connection, with the advent of Hyperledger Fabric, permissioned blockchain applications in supply chains have been growing.

As noted by Charles et al. [4], many scholars have been investigating how blockchain features such as security, decentralization, immutability, and transparency bring benefits to supply chain management. For example, Park and Li [5] reported how adopting Hyperledger Fabric for collaboration between Walmart and its suppliers to ensure confidentiality, authenticity, and nonrepudiation to all transactions led to food traceability and safety as well as information sharing and trust among the supply chain stakeholders in food distribution. Also, the analytical models by Ullah et al. [6] showed that the benefits of blockchain adoption in the after-sales service supply chain include gaining consumers' trust, which leads to increased sales and profits for manufacturers and retailers. Moreover, Pontis et al. [7] found through a questionnaire, literature review, and interviews that blockchain technology improves supply chain capabilities including the ability to react to uncertainty in supply chains. Some other scholars have used theories to explore the benefits of blockchain deployment in supply chain management. For example, Madhani [8] used Wernerfelf's [9] resource-based view (RBV) to demonstrate the capabilities and benefits of blockchain deployment in the supply chain. Also, Patil et al. [10] used network theory (NT) to reveal that the supply chain collaboration and learning of an organization positively influence its blockchain assimilation, and perceived network prominence of an organization moderates the influence of supply chain learning on its blockchain assimilation. Moreover, Meier et al. [11] used Teece et al.'s [12] dynamic capabilities to demonstrate that supply chain traceability and related sensing capabilities are benefits of blockchain-driven circular supply chain management while Treiblmaier [13] presented a framework built on principal agent theory (PAT), transaction cost analysis, RBV, and NT which provides the foundation for further systematic and theory-based research for the exploration of blockchain applications in supply chains.

However, the recent discontinuation of the blockchain platform TradeLens, co-developed by IBM and Maersk to process and track shipment records and enable the involved supply chain stakeholders (e.g., suppliers, forwarders, insurers, government agencies, cargo owners, ports operators, and customers) to interact efficiently and share information for supply chain management, was due to the lack of acceptance and adoption of the involved supply chain stakeholders [14]. For the case of the discontinuation of TradeLens, two issues were noticed. First, for efficient information sharing and interaction, the users of TradeLens might not have needed the blockchain technology. Other existing Internet technologies, such as three-tier or multi-tier server-client systems and cloud computing, can provide efficient information sharing and interaction. For example, those users can obtain the required information from a web database through a web server in a three-tier architecture, multi-tier architecture, or cloud storage from the involved supply chain stakeholders (e.g., suppliers, forwarders, insurers, and customers) instead of the blockchain-based TradeLens. Also, some suppliers may not want to share information with their competitors through the blockchain-based TradeLens. Therefore, these TradeLens users did not regard the blockchain features as useful. Second, the factors influencing the TradeLens users' acceptance of blockchain technology, especially whether the blockchain features (e.g., decentralization, shareability, and transparency) fit the users' performance needs, must be understood.

1.1. Significance of This Study

Inspired by this discontinuation of the blockchain application in supply chain management, the researchers had concerns about the applicability of the existing blockchain adoption models and proposed this study to explore a more appropriate model. The blockchain adoption models in the literature lack consideration of whether the blockchain technology fits the users' performance needs. In this study, a new blockchain technology adoption model that considers whether the technology fits the uses' needs is explored to investigate which factors really affect the acceptance and actual adoption of blockchain applications for supply chain management. Nowadays, technological development and advancement are important for a community to sustain itself. Therefore, technical sustainability, which refers to the practices required to maintain the smooth running of the technology, leading the technology to advance, and keep the technology resilient [15], must be explored. For a form of technology to keep on operating and advancing, that technology must first be accepted and adopted by the technology users. The study of supply chain stakeholders' adoption of blockchain applications is significant as that adoption is a pre-requisite for the technical sustainability of blockchain applications for supply chain management. Also, this study is significant in the sense that it has implications for a blockchain adoption model that considers whether blockchain technology fits supply chain stakeholders' tasks. This model can be used to understand which factors really affect blockchain adoption in supply chains and determine which supply chain applications need blockchain.

1.2. Research Aims and Questions

For the exploration of blockchain technology adoption for supply chain management, previous studies in this area should be reviewed. This study aims to critically review the existing studies related to blockchain technology adoption for supply chain management with the intention to obtain insights from the literature and propose a more universal approach with a more appropriate theoretical model for future research on factors influencing blockchain adoption in supply chain management. The review mainly focuses on the previous studies about users' adoption of permissioned blockchain in supply chains as many blockchain-based supply chain applications are built on permissioned blockchains. To cover the related literature, the review also considered previous studies about the adoption of permissionless blockchain in supply chains and the previous studies in this area that did not explicitly state which blockchain type was used.

The concerns about the literature are how the previous studies were conducted to explore the factors affecting blockchain adoption for supply chain management and what factors were found in the literature. To this end, the following research questions are addressed to explore the factors affecting blockchain adoption in supply chains:

1. What are the research methods used in the literature?
2. What are the theories or models adopted in the literature?
3. What are the findings in the literature?
4. What are the insights or implications in terms of research design and blockchain adoption theories or models obtained from research questions 1 to 3?

1.3. Related Research Work

Eight relevant previous literature review articles were identified, i.e., Refs. [16–23]. All eight articles are systematic literature reviews. The studies by AlShamsi et al. [16] and Taherdoost [17] are similar—they both reviewed the blockchain adoption models and the domains or business sectors that these adoption models were applied to. In addition to reviewing the blockchain adoption models, Xie et al. [18] reviewed research methods while AlShamsi et al. [16] reviewed the research methods, primary purpose, and target participants in previous studies. Moreover, in addition to reviewing the factors affecting blockchain adoption, Happy et al. [19] and Xie et al. [18] considered the outcomes of blockchain adoption. Similarly, many previous literature reviews (e.g., Refs. [20–28]) have looked into the benefits brought about by blockchain adoption in the supply chain. Kafeel et al. [23], Shin et al. [21], and Vu et al. [22] also investigated the barriers or challenges that influence the adoption of blockchain technology. Mohammed et al. [20] explored all three areas (i.e., factors, benefits, and challenges) pertaining to blockchain adoption. Unlike the studies by AlShamsi et al. [16] and Taherdoost [17], which focused on different business sectors (e.g., education, finance, healthcare, and supply chain), Happy et al. [19], Kafeel et al. [23], Mohammed et al. [20], Shin et al. [21], Vu et al. [22], and Xie et al. [18] focused solely on the supply chain sector.

Significantly, while previous studies conducted systematic literature reviews, this study took a critical approach to conduct a literature review on the research methods, main technology adoption theories or models, and factors affecting the use of blockchain with the intention to provide information for what the future research design on blockchain adoption for supply chain management should be. Based on this critical literature review, a conceptual framework was formulated.

1.4. Commonly Used Theoretical Models

Based on the relevant literature review studies, there is a large variety of blockchain technology adoption models for supply chain management identified in the literature. These models include Tornatzky et al.'s [29] technology–organization–environment (TOE) framework, Davis' [30] technology acceptance model (TAM), Venkatesh et al.'s unified theory of acceptance and use of technology (UTAUT) [31] and extended UTAUT (UTAUT2) [32], Parasuraman's [33] technology readiness index (TRI), Goodhue and Thompson's [34] task–technology fit (TTF), DeLone and McLean's [35] information systems success (ISS) model, institutional theory (IT) [36,37], Westaby's [38] behavioral reasoning theory (BRT), Koppenjan and Groenewegen's [39] institutional framework (IF), Pfeffer and Salancik's [40] resource dependency theory (RDT), hesitant fuzzy set (HFS) [41,42], social network theory (SNT) [43], and Ram and Sheth's [44] innovation resistance theory (IRT). As identified in the relevant literature review studies, TOE, TAM, and UTAUT were commonly used. Many previous studies used their extended or integrated versions.

1.4.1. Technology–Organization–Environment Framework

The TOE framework consists of constructs in the technological (T), organizational (O), and environmental (E) contexts that explore how an organization adopts technology and implements technological innovations. The T context refers to the technological issues relevant to an organization such as technology features and infrastructure. The O context contains the constructs of an organization such as organizational structure, financial status, and size. The E context refers to the constructs surrounding an organization such as dealings with suppliers, partners, competitors, and the government. The TOE framework examines the T, O, and E constructs from an organizational perspective [45,46]. This framework does not strictly fix any constructs in each of the three contexts (i.e., T, O, and E contexts). Instead, as different organizations may have different constructs in the T, O, and E contexts, this framework provides flexibility for setting constructs in the T, O, and E contexts for different organizations. For example, the E constructs include perceived industry pressure and perceived government pressure for small businesses in Hong Kong [47] while Internet competitive pressure, website competitive pressure, and e-commerce competitive pressure were set in the E context for small firms in Portugal [48].

1.4.2. Technology Acceptance Model

In the TAM, a user's actual usage (AU) of technology is influenced by that user's behavioral intention (BI) to use that technology. A user's BI is in turn influenced by that user's perceived usefulness (PU) and perceived ease of use (PEOU). PU is "the degree to which a person believes that using a particular system would enhance job performance" [30]. PEOU is "the degree to which a person believes that using a particular system would be free from effort" [30]. As indicated in the TAM, if the blockchain-based system is easy to use and makes a user perform well, that user is more likely to use the blockchain-based system and, eventually, will actually use the system. Figure 1 visualizes the TAM. The arrow indicates an influence in the figure.

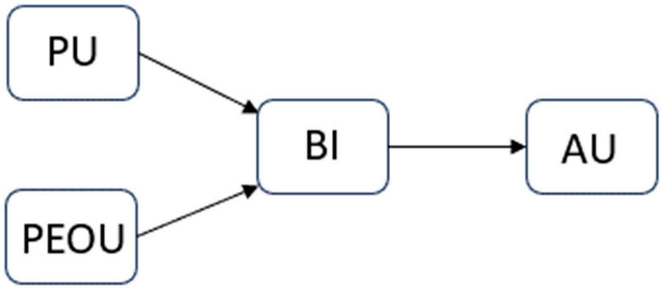

Figure 1. Davis' [30] TAM.

1.4.3. Unified Theory of Acceptance and Use of Technology

UTAUT was formulated through a review and synthesis of eight theories/models. These eight theories/models are Fishbein and Ajzen's [49] theory of reasoned action (TRA), TAM, the motivational model (MM) [50,51], the theory of planned behavior (TPB) [52,53], Taylor and Todd's [54] combined TAM and TPB, Thompson et al.'s [55] model of personal computer utilization (MPCU), Rogers' [56] innovation diffusion theory (IDT)/diffusion of innovation (DOI), and social cognitive theory (SCT) [57,58]. UTAUT contains moderating (or indirect) effects (i.e., gender, age, experience, and voluntariness of use), but they are not usually examined in the literature as the previous studies intended to obtain findings that could be applicable to any gender and any age, and as expected, there was not much difference in the experience of using such a new form of blockchain technology and the voluntariness of use as the users were supposed to use the technology which had been adopted in their organizations.

As theorized by UTAUT, supply chain stakeholders' adoption of blockchain technology is indicated by their AU behavior of that technology which is determined by their BI to use that technology and facilitating conditions (FC) such as Internet access, required software and hardware, technical support, and training. The users' BI is in turn determined by their own three perceptions—(1) performance expectancy (PE), which is similar to PU in the TAM, is the degree of the users' belief that using blockchain technology can enhance their task performance (e.g., auditable transactions and efficient product tracking), (2) effort expectancy (EE), which is similar to PEOU in the TAM, is the degree of the users' perception of their digital literacy, self-efficacy, and ease of use of blockchain technology, and (3) social influence (SI), which is the extent to which the users perceive that the people around them such as suppliers, supervisors, colleagues, partners, and customers expect that they should perform the blockchain technology usage behavior. Figure 2 shows UTAUT without moderating effects. Again, the arrow indicates an influence in the figure.

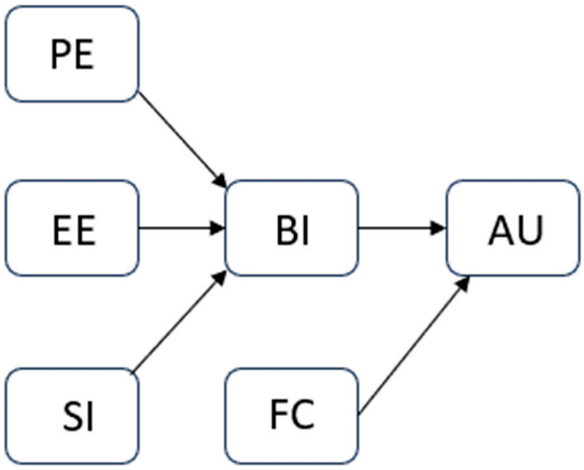

Figure 2. Venkatesh et al.'s [31] UTAUT without moderating effects.

2. Research Methodology

This study applied a critical review approach. According to Jesson and Lacey [59], a critical review should demonstrate awareness of the current state of knowledge, as well as strengths and limitations of the current literature, while a systematic review uses a systematic method to identify relevant studies in order to minimize biases and error. Both critical and systematic reviews should have with implications that lead to a new state of knowledge. The critical literature review processes are described in the following subsections:

2.1. Literature Search

First, the following inclusion criteria were set for the literature search:

- Studies published in books, journals, and conference proceedings from 2013 (the year in which the publications about blockchain adoption in the supply chain began [28]) to 2023 (the year when this literature search was conducted) in English
- Studies about blockchain adoption, acceptance, or use for supply chain management
- Studies related to theories, models, or frameworks for blockchain adoption, acceptance, or use

The search terms derived from the inclusion criteria included "blockchain", "adoption", "acceptance", "use", "supply chain", "theories", "models", "frameworks", "English", and "from 2013 to 2023". These search terms were concatenated with some logical operators for the literature search through the Scopus search tool. Scopus was mainly used as it covers different areas (e.g., business, science, and supply chain) more comprehensively [60] and provides a friendly user interface that facilitates searching [14]. In the literature search using Scopus, the search string TITLE-ABS-KEY ("Blockchain" AND ("adoption" OR "acceptance" OR "use") AND ("theories" OR "models" OR "frameworks") AND "supply chain") AND (LIMIT-TO (PUBYEAR, 2023) OR LIMIT-TO (PUBYEAR, 2022) OR LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015) OR LIMIT-TO (PUBYEAR, 2014) OR LIMIT-TO (PUBYEAR, 2013)) AND (LIMIT-TO (LANGUAGE, "English")) was used to search through the article title, abstract, and keywords. Then, 1177 articles were found.

2.2. Search Results

Among the search results, only the results related to blockchain technology were reviewed. After reviewing these search results and recursively searching the articles from the reference lists from literature review articles (e.g., Refs. [16,17,19]), a total of 85 relevant previous studies published from 2017 to 2023 were found. Figure 3 shows the number of relevant articles published in each year from 2017 to 2023. There is a trend of an increasing number of publications, reflecting growing attention to studies about blockchain adoption in supply chains. For research questions 1 to 3, each article from the search results is divided into five fields. The five fields are the source, reference model/theory, data collection method, analysis type, and major findings. These articles published from 2017 to 2023 are listed in Table 1 (a) to (g).

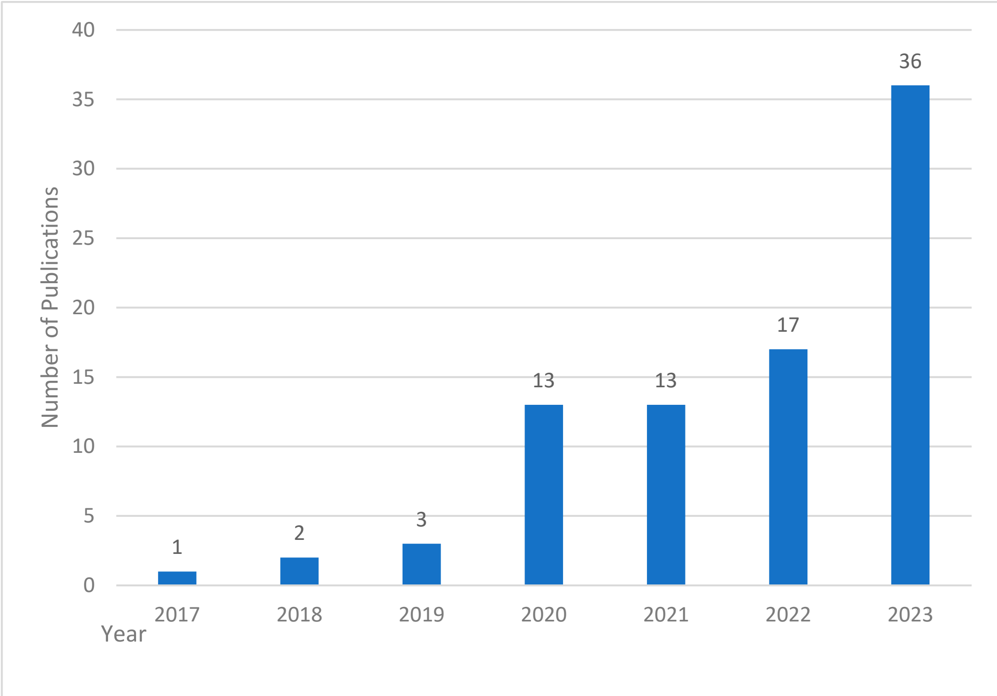

Figure 3. Publications from 2017 to 2023.

The search results were analyzed with reference to the technology adoption theories or models involved in the studies. Those theories or models were either solely adopted, extended, or combined with other theories or models to form integrated frameworks. Among the technology adoption theories, models, or methods used to form models, as shown in Table 2, the TOE was the most frequently used with 33 studies, followed by the TAM with 16 studies, and then followed by the UTAUT with 14 studies.

Table 3 shows that survey was the most common method used to collect data by the researchers on blockchain adoption in supply chain, as indicated by it representing 57.7% (60/104) of all data collection methods. Also, survey methods were frequently used in each period from 2017 to 2023.

In Table 4, the quantitative analysis type was the main analysis type, as indicated by 72.9% (62/85) of all analysis types commonly used in each period from 2017 to 2023.

Unlike the TAM and UTAUT in which the constructs are predefined, the constructs for TOE were determined by the researchers. Table 5 shows the identified constructs in each TOE context that have a significant effect on blockchain adoption in supply chains.

Table 1. (a) Previous studies on blockchain adoption published in 2017; (b) previous studies on blockchain adoption published in 2018; (c) previous studies on blockchain adoption published in 2019; (d) previous studies on blockchain adoption published in 2020; (e) previous studies on blockchain adoption published in 2021; (f) previous studies on blockchain adoption published in 2022; (g) previous studies on blockchain adoption published in 2023.

(a)

Study	Reference Model/Theory	Data Collection Method	Analysis Type	Major Finding(s)	Major Contribution
Supranee and Rotchanakitumnuai [61]	Authors' own model based on previous studies (i.e., Refs. [62–66])	Survey	Quantitative	Perceived benefits and inter-organizational trust influence blockchain adoption.	A new model is proposed.

(b)

Study	Reference Model/Theory	Data Collection	Analysis Type	Major Finding(s)	Major Contribution
Francisco and Swanson [67]	UTAUT	Review	Qualitative	The findings contain the influence of performance expectancy, effort expectancy, social influence, and facilitating conditions on behavior intention to use blockchain technology which in turn influences blockchain technology use behavior.	A new application of UTAUT is proposed.
Kamble et al. [68]	TAM, TPB, and TRI	Survey	Quantitative	Perceived usefulness, attitude, and perceived behavioral control affect the behavioral intention to adopt blockchain technology. Subjective norm has a negligible impact on behavioral intention to adopt blockchain technology.	A new integration of TAM, TPB, and TRI is proposed.

(c)

Study	Reference Model/Theory	Data Collection Method	Analysis Type	Major Finding(s)	Major Contribution
Queiroz and Wamba [69]	TAM and UTAUT	Survey	Quantitative	Performance expectancy is an important predictor of behavioral intention, and behavioral intention is a significant predictor of behavioral expectation in both the USA and India. Trust among supply chain stakeholders is an important predictor of behavioral expectation in India only. Facilitating conditions influence behavioral intention and expectation in the USA.	A new exploration and comparison of impacts in different countries (i.e., USA and India) is proposed.

Table 1. *Cont.*

(c)					
Study	**Reference Model/Theory**	**Data Collection Method**	**Analysis Type**	**Major Finding(s)**	**Major Contribution**
Wamba and Queiroz [70]	UTAUT	Survey	Quantitative	In the Brazilian supply chain case, there is a positive effect of social influence on facilitating conditions, performance expectancy, and effort expectancy. Facilitating conditions have a positive effect on behavioral intention to adopt blockchain. Effort expectancy has a positive effect on behavioral intention to adopt blockchain.	New impacts are identified.
Yang [71]	TAM	Survey	Quantitative	Customs clearance and management, digitalizing and easing paperwork, standardization, and platform development dimensions positively affect the intention to use blockchain technology in the maritime shipping supply chain.	New factors are identified.
(d)					
Study	**Reference Model/Theory**	**Data Collection Method**	**Analysis Type**	**Major Finding(s)**	**Major Contribution**
Farooque et al. [72]	Fontela and Gabus' [73] Fuzzy decision-making trial and evaluation laboratory (DEMATEL)	Survey	Quantitative	The immaturity of the technology, technical challenges for collecting supply chain data in real-time, a lack of new organizational policies for using technology, and a lack of government policy/regulation guidance and support are the blockchain adoption barriers.	A new model is proposed.
Karamchandani et al. [74]	TAM, DOI/IDT, and TOE	Survey	Quantitative	The results of this study indicate that "Perceived enterprise blockchain benefits" positively affect the perceived usefulness of enterprise blockchain for all supply chain management dimensions. The perceived usefulness of enterprise blockchain for the service supply chain management dimensions has a positive effect on perceived incremental profitability due to enterprise blockchain adoption.	Some new factors and new impacts are identified.
Malik et al. [75]	TOE	Interview	Qualitative	Perceived benefits, compatibility, complexity, organization innovativeness, organizational learning capability, competitive intensity, government support, trading partner readiness, and standards uncertainty influence organizational adoption of blockchain.	Some new factors are identified.

Table 1. *Cont.*

(d)					
Study	**Reference Model/Theory**	**Data Collection Method**	**Analysis Type**	**Major Finding(s)**	**Major Contribution**
Orji et al. [76]	TOE	Review, interview, and survey	Quantitative	The availability of specific blockchain tools, infrastructural facilities, and government policy and support is the topmost ranked significant factor that influences the adoption of blockchain in the freight logistics industry.	Some new factors are identified.
Park [77]	UTAUT and TOE	Review and survey	Quantitative	The UTAUT constructs (i.e., performance expectancy, effort expectancy, social influence, and facilitating conditions) have significant effects on the attitude and sustainable usage intention of blockchain. The TOE constructs also have a significant influence on attitude and the sustainable usage intention of blockchain.	A new integration of UTAUT and TOE is proposed.
Sahebi et al. [78]	Ishikawa et al.'s [79] fuzzy Delphi technique and best–worst method	Review	Mixed-quantitative analyses on qualitative data	Regulatory uncertainty, a lack of knowledge/employee training, and high sustainability costs are important blockchain adoption barriers.	A new model is proposed.
Saurabh and Dey [80]	Rating-based conjoint analysis to explore the blockchain adoption drivers	Survey	Quantitative	Disintermediation, traceability, price, trust, compliance, coordination and control, and utilities can influence the supply chain actors' adoption-intention decision processes.	A new model is proposed.
Ullah [81]	TAM, TPB, and TRI	Survey	Quantitative	In TRI, optimism and innovativeness have a significant impact on perceived ease of use. The TAM constructs (i.e., perceived ease of use, perceived usefulness, and attitude) and the TPB construct (i.e., perceived behavioral control) affect the behavioral intention to use blockchain technology.	New impacts are identified.
Wahab et al. [82]	UTAUT	Review	Qualitative	For the Malaysian warehouse industry, a new conceptual research framework has been developed. In this framework, performance expectancy, effort expectancy, social influence, facilitating conditions, and price value are the independent variables, and perceived intention of blockchain technology adoption is the dependent variable.	A new model is proposed, and a new sector is considered.

Table 1. *Cont.*

(d)					
Study	**Reference Model/Theory**	**Data Collection Method**	**Analysis Type**	**Major Finding(s)**	**Major Contribution**
Wamba et al. [83]	TOE, authors' own designed model showing the relationship between blockchain adoption and supply chain performance	Survey	Quantitative	Knowledge sharing and trading partner pressure play an important role in blockchain adoption, and supply chain performance is significantly influenced by supply chain transparency and blockchain transparency.	A new model is proposed.
Wong et al. [84]	TOE	Survey	Quantitative	Competitive pressure, complexity, cost, and relative advantage have significant effects on the behavioral intention of Malaysian small- and medium-sized enterprises to adopt blockchain technology in supply chain management.	Some new factors are identified.
Wong et al. [85]	UTAUT	Survey	Quantitative	Facilitating conditions, technology affinity, and technology readiness have a positive influence on the intention to use blockchain for supply chain management and regulatory support moderates the effect of facilitating conditions.	Some new factors and a new impact are identified.
Yadav et al. [86]	A model based on the integration of Warfield's [87] interpretive structural modeling (ISM) and DEMATEL together with Godet's [88] fuzzy cross-impact matrix multiplication applied to classification (MICMAC)	Survey	Quantitative	"Lack of government regulation and lack of trust among agro-stakeholder to use blockchain" are significant adoption barriers of blockchain in the Indian agriculture supply chain.	A new model is proposed, and a new sector is considered.

Table 1. *Cont.*

(e)					
Study	**Reference Model/Theory**	**Data Collection Method**	**Analysis Type**	**Major Finding(s)**	**Major Contribution**
Alazab et al. [89]	UTAUT, TTF, and ISS	Survey	Quantitative	ISS, TTF, and UTAUT models positively influence the key factors affecting supply chain employees' willingness to adopt blockchain while inter-organizational trust has a significant effect on the relationship between the UTAUT dimension and intention to adopt blockchain.	New impacts are identified.
Aslam et al. [90]	Authors' own designed model based on supply chain practices of the oil industry in Pakistan	Survey	Quantitative	Supply chain management practices positively impact operational performance.	A new model is proposed.
Balci and Surucu-Balci [91]	A model formed by ISM	Interview	Qualitative	Lack of support from influential stakeholders, lack of understanding regarding blockchain, and lack of government regulations are the blockchain adoption barriers.	A new model is proposed.
Jardim et al. [92]	Gregor and Jones' [93] design science research to develop adoption drivers	Survey	Quantitative	Dependence of other players' acceptance and adoption, the support and assistance given by the technology provider, the trust level in the technology itself, automation and inefficiency reduction, traceability, information tracking, and the transparency guaranteed by smart contracts are identified blockchain adoption drivers.	A new model is proposed.
Kamble et al. [94]	TAM and TOE	Survey	Quantitative	Partner readiness, perceived ease of use, competitor pressure, and perceived usefulness are factors.	Some new factors are identified.
Kouhizadeh et al. [95]	TOE	Survey	Quantitative	Supply chain and technological barriers are the most critical barriers among both academics and industry experts.	Some new limitations are identified.
Kumar Bhardwaj et al. [96]	TAM, DOI/IDT, and TOE	Interview and survey	Quantitative	Relative advantage, technology compatibility, technology readiness, top management support, perceived usefulness, and vendor support have a positive influence on the intention of Indian small- and medium-sized enterprises to adopt blockchain technology in their supply chains. The complexity of technology and cost concerns are barriers to technology adoption by small- and medium-sized enterprises.	Some new factors, new impacts, and new limitations are identified.

Table 1. *Cont.*

(e)

Study	Reference Model/Theory	Data Collection Method	Analysis Type	Major Finding(s)	Major Contribution
Lanzini et al. [97]	TOE	Review and survey	Quantitative	The small- and medium-sized enterprises' intention to adopt blockchain-based applications in supply chain management is primarily influenced by organizational rather than technological and environmental factors.	A new exploration in different enterprise sizes.
Maden and Alptekin [98]	TAM	Not specified	Not specified	Intention, job relevance, and output quality are more important factors influencing blockchain adoption.	Some new factors are identified.
Queiroz et al. [99]	UTAUT	Survey	Quantitative	Facilitating conditions, trust, social influence, and effort expectancy are the most critical constructs that directly affect blockchain technology adoption in the Brazilian operations and supply chain management context.	Some new factors are identified.
Sunmola et al. [100]	Building block model in three phases—pre-adoption, adoption, and post-adoption	Interview	Qualitative	Blockchain technology platform offerings, strategic responses, and adoption readiness are factors in the preadoption phase. Supply chain networks, blockchain costs, firm resources, law and government, and blockchain compatibility are factors for blockchain adoption.	A new model is proposed and a new concept is provided (i.e., pre-adoption, adoption, and post-adoption).
Suwanposri et al. [101]	TOE	Interview	Qualitative	Operational efficiency, suitable application, supportive government policies and regulations, and stakeholders' cooperation are TOE factors, and each of the focused sectors weighs environmental factors differently due to different goals.	Some new factors are identified.
Tan and Sundarakani [102]	TAM	Interview	Qualitative	Smart contracts can be set up at critical points along the shipment route to ensure greater security and transparency.	A new application is considered.

(f)

Study	Reference Model/Theory	Data Collection Method	Analysis Type	Major Finding(s)	Major Contribution
Agi and Jha [20]	DOI/IDT, Iacovou et al.'s [103] model	Survey	Quantitative	The relative advantage of the technology and external pressure influence blockchain adoption in the supply chain.	A new model is proposed.

Table 1. *Cont.*

(f)

Study	Reference Model/Theory	Data Collection Method	Analysis Type	Major Finding(s)	Major Contribution
Agrawal et al. [104]	TOE	Review and survey	Quantitative	Technological barriers (e.g., lack of blockchain standardization), organizational barriers (e.g., lack of financial resources), and environmental barriers (e.g., lack of government regulation) affect blockchain adoption in Indian manufacturing supply chains.	New limitations are identified.
Chittipaka et al. [105]	TOE	Survey	Quantitative	Relative advantage, trust, compatibility, security, firm's IT resources, higher authority support, firm size, monetary resources, rivalry pressure, business partner pressure, and regulatory pressure influence blockchain technology adoption in Indian supply chains.	Some new factors are identified.
Chowdhury et al. [106]	TAM	Survey	Quantitative	Involvement in resilient organizational practices and the user-friendly implementation of blockchain technology has a significant and positive influence on the intention to adopt blockchain for risk management in the operations and supply chain context.	New impacts are identified.
Deng et al. [107]	TOE	Survey	Quantitative	Cost saving, complexity, relative advantage, top management support, supply chain cooperation, and government support influence blockchain adoption in the supply chain.	Some new factors are identified.
Ganguly [108]	TOE	Interview	Qualitative	Forty elements related to technical challenges, organizational challenges, and environmental challenges were identified.	Some new factors are identified.
Gökalp et al. [109]	TOE	Interview	Qualitative	Environment-related determinants are more critical than technology-related or organization-related determinants.	Some new factors are identified.
Hartley et al. [110]	DOI/IDT and IT	Interview	Qualitative	Government regulations regarding product origin, organizations using updated cloud-based information systems, and organizations working with third-party consultants affect the intention to adopt blockchain. Also, organizations that face normative pressures to adopt blockchain supply chain applications and recognize blockchain's relative advantage, compatibility, and complexity are more likely to adopt blockchain supply chain applications.	New impacts are identified.

Table 1. *Cont.*

(f)					
Study	**Reference Model/Theory**	**Data Collection Method**	**Analysis Type**	**Major Finding(s)**	**Major Contribution**
Jain et al. [111]	UTAUT	Survey	Quantitative	Buying motives (i.e., economic motives, hedonic motives, and critical motives) and some UTAUT constructs (i.e., performance expectancy, facilitating conditions, and attitude) explain blockchain acceptance. The risk of contamination enhances blockchain adoption intention and mediates fashion motives and intention.	Some new factors and a new impact are identified.
Kapnissis et al. [112]	UTAUT	Survey	Quantitative	Performance expectancy, social influence, trust, and blockchain functional benefits significantly positively influence the Greek shipping industry's behavioral intention to adopt blockchain technology. Behavioral intention has a significant positive influence on the industry's behavioral expectations.	Some new factors are identified.
Kumar et al. [113]	TAM	Survey	Quantitative	Perceived security and privacy in developing the trust, ease of use, and usefulness of blockchain-enabled systems are significant factors influencing blockchain adoption. The relationship between perceived ease of use and attitude is mediated by perceived usefulness. The strong influence of attitude on adoption intention represents the consumer interest in blockchain to understand product provenance.	Some new factors and new impacts are identified.
Li et al. [114]	TOE	Survey	Quantitative	Relative advantage, internal leadership, human resources capability, scalability, and ease of use are critical success factors for blockchain implementation.	Some new factors are identified.
Mthimkhulu and Jokonya [115]	TOE	Review	Quantitative	Technical factors (i.e., security, complexity, and cost), organizational factors (i.e., management support), and environmental factors (i.e., competition, IT policy and regulations, and support) affect the adoption of blockchain technology in the supply chain and logistics industry.	Some new factors are identified.

Table 1. *Cont.*

(f)					
Study	**Reference Model/Theory**	**Data Collection Method**	**Analysis Type**	**Major Finding(s)**	**Major Contribution**
Nath et al. [116]	TOE and DOI/IDT	Survey	Quantitative	Relative advantage, compatibility, perceived trust, top management considerations, absorptive capacity, information sharing and collaborative culture, and trading partners' influence affect supplier firms' intention to adopt blockchain in supply chains. Supplier development for sustainability significantly moderates the several drivers' (e.g., relative advantage, compatibility, top management considerations, and trading partners' influence) effects on blockchain adoption.	Some new factors and new impacts are identified.
Oguntegbe et al. [117]	BRT and TOE	Review	Qualitative	Managers who consider the technological benefits associated with blockchain capacity are able to provide stakeholders with new opportunities and embrace adoption strategies such as product launch and partnership formation while also considering barriers such as market fragmentation, scarcity of research, and regulatory restrictions.	New impacts and new limitations are identified.
Saputra and Darma [118]	TAM	Survey	Quantitative	Public influence affects the perceived usefulness of the blockchain-based My-T Wallet application. The user interface in My-T Wallet affects the perceived ease of use. The users' positive behavior affects their intention to use the My-T Wallet application.	New factors are identified, and a new application is considered.
Yadlapalli et al. [119]	TOE	Interview and review	Qualitative	Complexity challenges associated with the technology, organizational structure, external environment, and issues of compatibility with existing systems, software, and business practices are concerns about blockchain technology implementation.	Some new factors are identified.

Table 1. *Cont.*

(g)					
Study	**Reference Model/Theory**	**Data Collection Method**	**Analysis Type**	**Major Finding(s)**	**Major Contribution**
Adel and Younis [120]	Authors' own designed model explored through mixed methods	Review, interview, and survey	Mixed	Entrepreneurial orientation positively and significantly affects the blockchain technology adoption strategy in Egyptian banks. Blockchain technology adoption strategy positively and affects significantly electronic supply chain management diffusion.	A new model is proposed.
Ahmed et al. [121]	TPB and TRI	Survey	Quantitative	Perceived ease of use influences perceived usefulness and attitude toward blockchain acceptability. Perceived usefulness has a significant impact on the attitude to use. Trust in blockchain has a significant impact on building up the attitude to use blockchain technology.	A new integration of TRI and TPB is proposed.
Ali et al. [122]	TOE and DOI/IDT	Survey	Quantitative	Top management support, trialability, external support, and competitive pressure influence the intention to adopt blockchain.	Some new factors are identified.
Baral et al. [123]	TOE	Review and survey	Quantitative	Perceived benefits, cost, relative advantage, and security, top management support, organizational readiness, and blockchain knowledge, competitive pressure, regulatory environment, government support, and intention to adopt the technology all contribute to blockchain adoption by keeping the intention to adopt the technology as a mediating variable.	Some new factors are identified.
Bhat and Amin [124]	IF	Interview	Qualitative	Transparency, business model, trust, organizational readiness, and auditing issues under institutional group, diffusion of technology, lack of clarity, efficiency, openness, automation, and decentralization under market group, and efficiency, authenticity, fault tolerance, immutability, reliability, and process integrity under technical group are identified factors for the acceptability of blockchain in horticulture for supply chain management.	A new application of IF is proposed.
Boakye et al. [125]	TOE	Survey	Quantitative	Relative advantage, cost, and compatibility significantly influence blockchain adoption in supply chain finance in small and medium enterprises.	New sectors are considered.

Table 1. *Cont.*

(g)					
Study	**Reference Model/Theory**	**Data Collection Method**	**Analysis Type**	**Major Finding(s)**	**Major Contribution**
Cai et al. [126]	TAM	Survey	Quantitative	The traceability, transparency, information sharing, and decentralization of blockchain enhance the perceived usefulness of blockchain in supply chain resilience and responsiveness and the ability to withstand disruption risks and supply and demand coordination risks encountered in the supply chain.	New impacts are identified.
Çaldağ and Gökalp [127]	TOE	Review and survey	Quantitative	Top management support, government support, competitive pressure, inter-organizational trust, and organizational culture are the five most essential sub-factors of blockchain-based medical supply chain management system adoption while complexity, standardization, information technology infrastructure, perceived benefit, and financial resources are the five least significant factors for blockchain-based medical supply chain management system adoption.	Some new factors and new impacts are identified.
Çolak and Kağnıcıoğlu [128]	A model formulated using DEMATEL and partial Least-squares structural equation modeling (PLS-SEM)	Survey	Quantitative	There is a strong association between inter-firm technology acceptance characteristics in explaining behavioral intention while other variables mainly influence dependency. Trust has the most significant impact on those variables with cooperation. Cooperation is the most influential variable affecting behavioral intention, followed by dependency and knowledge sharing. Dependency fully mediates the effects of the variables on behavioral intention. The relationship between trading partner trust and behavioral intention is fully mediated by knowledge sharing, while it also partially mediates the influence of cooperation.	A new model is proposed.

Table 1. *Cont.*

(g)					
Study	**Reference Model/Theory**	**Data Collection Method**	**Analysis Type**	**Major Finding(s)**	**Major Contribution**
Chen et al. [129]	TOE	Review	Quantitative	This study adopted bi-objective optimization-based fairness-aware large-scale collective opinion generation framework to examine the technological, organizational and environmental dimensions in TOE. The findings reveal that the organizational context exhibits the most severity, the environmental context is the next one, and the technological context comes last.	A new model and new impacts are identified.
Ganeshkumar et al. [130]	A model formulated using the analytical hierarchy process (AHP)	Review and interview	Qualitative	The five barriers that emerged as the most frequently mentioned are knowledge, cost, time, digitalization, and demand. Also, the challenge of implementing the blockchain lies in balancing the need for transparency with concerns over open-source information being accessed by competitors.	A new model and new limitations are identified.
Giri and Manohar [131]	TAM and MM	Survey	Quantitative	For perceived usefulness, there is a stronger mediating effect between private blockchain-based collaboration and behavioral intention to use. For perceived ease of use, there is a stronger mediating effect between public blockchain-based collaboration and behavioral intention to use.	A new exploration of the impacts of private and public blockchain-based collaboration is proposed.
Guan et al. [132]	RDT and TOE	Survey	Quantitative	Interpersonal connections that facilitate a mutual exchange of favors, relative advantage, technology complexity, organizational readiness, and cost affect supply chain alignment, which in turn positively affects blockchain adoption.	Some new factors and new impacts are identified.
Guan et al. [133]	TOE	Survey	Quantitative	Only TOE factors (i.e., technological, organizational, and environmental factors) are insufficient to predict blockchain adoption; supply chain factors (i.e., supply chain collaboration, information sharing, trust in trading partners, trading partners' power, and interpersonal connections) are also needed to predict blockchain adoption.	Some new factors are identified.

Table 1. *Cont.*

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Study	Reference Model/Theory	Data Collection Method	Analysis Type	Major Finding(s)	Major Contribution
Iranmanesh et al. [134]	Contingency theory	Survey	Quantitative	Intention to adopt blockchain is influenced by the contributions of blockchain to supply chain transparency and agility. Supply chain transparency, alignment, adaptability, and agility are interrelated. Market turbulence moderates the association between agility and the intention to adopt blockchain.	A new application of contingency theory is proposed.
Karuppiah et al. [135]	Decision-aid model using the fuzzy Delphi technique, Ju-Long's [136] grey theory, DEMATEL, and Zavadskas et al.'s [137] weighted aggregated sum product assessment (WASPA)	Review	Quantitative	Lack of knowledge about blockchain technology, the non-existence of universal regulatory binding, new organizational policies, reputation-based attacks, and vulnerability to cyber-attack are the top five challenges faced by leather garment manufacturing in adopting blockchain technology in supply chain management.	A new model is proposed.
Kuei and Chen [138]	A model based on ISM and MICMAC	Review	Quantitative	Risk management facilitation was found to be one of the major enable groups and is also one of the critical major enable groups of blockchain adoption in a supply chain.	A new model is proposed.
Kumar and Barua [139]	HFS	Review	Mixed	The prominent barriers to blockchain adoption are a lack of general standards, a lack of trust among partners, and a lack of understanding.	A new application of HFS is proposed.
Lin [140]	TOE	Survey	Quantitative	Knowledge absorption capability is the most important enabler of blockchain adoption in the organizational context, followed by perceived relative advantage in the technological context, and trading partner influence in the environmental context.	Some new factors are identified.

Table 1. *Cont.*

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Study	**Reference Model/Theory**	**Data Collection Method**	**Analysis Type**	**Major Finding(s)**	**Major Contribution**
Mohammed et al. [141]	TOE	Interview	Qualitative	Complexity, compatibility, cost in the technology context, organization size and knowledge in the organization context, and government support, competitive pressure, standardization, and compliance in the environment context are the most significant factors driving blockchain adoption in the food supply chain. The cost of implementation remains a significant barrier.	Some new factors and a new limitation are identified.
Mukherjee et al. [142]	TAM, UTAUT, and TPB	Survey	Quantitative	The employees of the retail stores surveyed have a positive intention and attitude toward adopting blockchain. However, the perceived behavioral control and effort expectancy do not influence blockchain adoption in the retail sector.	New impacts and new limitations are identified.
Patil et al. [10]	SNT	Survey	Quantitative	Supply chain learning of an organization will positively influence its supply chain collaboration, supply chain collaboration of an organization will positively influence its blockchain assimilation, supply chain learning of an organization positively influences its blockchain assimilation, and perceived network prominence of an organization will moderate the influence of supply chain learning on its blockchain assimilation.	A new application of SNT is proposed.
Samad et al. [143]	A model identified by a three-phase research framework and analyzed using ISM-DEMATEL	Interview	Qualitative	Real-time connectivity and information flow were identified as the most influencing enablers, whereas traceability was found to be the most prominent and resulting enabler.	A new model is proposed.

Table 1. *Cont.*

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Study	**Reference Model/Theory**	**Data Collection Method**	**Analysis Type**	**Major Finding(s)**	**Major Contribution**
Shahzad et al. [144]	UTAUT2	Survey	Quantitative	Performance expectancy, facilitating conditions, price value, hedonic motivation, user self-efficacy, and personal innovativeness positively influence user satisfaction which has a substantial progressive effect on habit. Furthermore, facilitating conditions, price value, habit, user self-efficacy, personal innovativeness, and user satisfaction have a progressive impact on continued intention to use blockchain technology in supply chain management.	Some new factors are identified.
Shahzad et al. [145]	TTF	Survey	Quantitative	Customer rating, ordering review, food tracking, navigational design, and user self-efficacy positively impact TTF. Self-efficacy positively moderates visual design and TTF, navigational design and TTF, and food tracking and TTF. TTF positively influences attitude and continued intention to use blockchain technology, and in turn, attitude positively influences continued intention to use blockchain technology.	A new application of TTF and new impacts are identified.
Sharma et al. [146]	A model based on fuzzy ISM, fuzzy MICMAC, and fuzzy DEMATEL	Review	Quantitative	Decentralization, data sovereignty, interoperability in the independent region, and two factors (infrastructure and smart systems in the linkage region) represent causes, and data management, operation responsiveness, data documentation, third-party involvement, and cost in the independent region represent effects. Further sensitivity in the inputs revealed very little change in outputs, thereby representing the robustness of the results.	A new model is proposed.
Sharma et al. [147]	UTAUT	Survey	Quantitative	Performance expectancy, effort expectancy, social influence, facilitating conditions, interfirm trust, and transparency influence stakeholders' intention to adopt blockchain.	Some new factors are identified.

Table 1. *Cont.*

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Study	**Reference Model/Theory**	**Data Collection Method**	**Analysis Type**	**Major Finding(s)**	**Major Contribution**
Sumarliah et al. [148]	Halal-focused attitude, DOI/IDT, and IT	Survey	Quantitative	The intention to adopt a blockchain-facilitated Halal traceability (BFHT) scheme in Indonesian firms' Halal food supply chain is affected by perceived attractiveness, as perceived attractiveness is considerably affected by institutional forces, which are significantly influenced by Halal-focused attitude. Firms that follow a completely Halal-focused attitude show higher awareness regarding institutional forces that motivate them to adopt a BFHT.	A new sector is considered.
Tasnim et al. [149]	TAM and TOE	Survey	Quantitative	Perceived usefulness, trading partners' pressure, and competitive pressure are the most important determinants of behavioral intention to adopt blockchain technology.	Some new factors are identified.
Thompson and Rust [150]	IRT, PAT, and TPB	Interview	Qualitative	Supply chain actors are hesitant to adopt blockchain technology as they fear jeopardizing relationships with the wholesalers who are reluctant to use blockchain as it threatens the competitive advantage of wholesalers by reversing existing asymmetries around trade, price, and provenance information.	A new integration of IRT, PAT, and TPB is proposed.
Vafadarnikjoo et al. [151]	A model based on neutrosophic AHP	Review and evaluation	Quantitative	Transaction-level uncertainties comprise the most critical barrier, followed by usage in the underground economy, managerial commitment, challenges in scalability, and privacy risks.	A new model is proposed.
Wang et al. [152]	Political, economic, environmental, social, and technological (PEEST) framework	Review and survey	Quantitative	The five most intense barriers are storage constraints, insufficient economic incentives, high integration costs, a lack of functional appeal, and ambiguity regarding data disclosure and public data management regulations.	A new model is proposed.
Wang et al. [153]	TOE	Review, interview, and survey	Mixed	Government policy and technological comparative advantage influence blockchain adoption; management commitment and financial expectations are the critical drivers of blockchain adoption decisions.	Some new factors are identified.

Table 1. *Cont.*

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Study	**Reference Model/Theory**	**Data Collection Method**	**Analysis Type**	**Major Finding(s)**	**Major Contribution**
Yadav et al. [154]	TOE	Review, interview, and survey	Mixed	The requirement for change in organizational structure and policies is the most prominent barrier to blockchain adoption. The requirement for Internet of Things infrastructure and lack of technical expertise are the most impactful barriers to blockchain adoption.	Some new limitations are identified.
Zhang et al. [155]	UTAUT	Survey	Quantitative	Facilitating conditions, social influence, effort expectancy, technology readiness, and technology affinity positively influence blockchain adoption while performance expectancy and trust negatively influence blockchain adoption.	Some new factors and new impacts are identified.
Zkik et al. [156]	Pythagorean fuzzy sets (PFS), cumulative prospect theory (CPT), and VlseKriterijumska Optimizcija I Kaompromisno Resenje (VIKOR)	Review and survey	Quantitative	The findings recommend developing transparency readiness in sustainability, collaboration among supply chain partners, upgrading data access control, management commitment, and collaboration with governments for implementing a blockchain for sustainable supply chain performance in e-agriculture supply chains.	A new model is proposed.

Table 2. The number of blockchain adoption theories/models/methods in the literature.

Model/Theory/Method	Year							Total
	2017	2018	2019	2020	2021	2022	2023	
TOE				6	5	10	12	33
TAM		1	2	2	4	3	4	16
UTAUT/UTAUT2		1	2	3	2	2	4	14
DOI/IDT				1	1	3	2	7
DEMATEL/Fuzzy DEMATEL				2			4	6
TPB		1		1			3	5
ISM/Fuzzy ISM				1	1		3	5
Authors' Own Design	1			1	1		1	4
TRI		1		1			1	3
MICMAC				1			2	3
TTF					1		1	2
IT						1	1	2
Fuzzy Delphi				1			1	2
ISS					1			1
Iacovou et al.'s Model						1		1
BRT						1		1
MM							1	1
RDT							1	1
IRT							1	1
PAT							1	1
AHP/Neutrosophic AHP							1	1
Fuzzy Fontela				1				1
Rating-based Conjoint				1				1
PFS							1	1
CPT							1	1
VIKOR							1	1
Best–Worst				1				1
Contingency Theory							1	1
PEEST							1	1
Design Science					1			1
Building Block					1			1
IF							1	1
PLS-SEM							1	1
SNT							1	1
Halal-focused Attitude							1	1
HFS							1	1
WASPA							1	1
Grey Theory							1	1

Table 3. The number of data collection methods in the literature from 2017 to 2023.

Data Collection	Year							Total
	2017	2018	2019	2020	2021	2022	2023	
Survey	1	1	3	11	8	11	25	60
Interview				2	5	4	8	19
Review		1		4	1	4	14	24
Not specified					1			1

Table 4. The number of analysis types in the literature from 2017 to 2023.

Analysis Type	Year							Total
	2017	2018	2019	2020	2021	2022	2023	
Quantitative	1	1	3	10	8	12	27	62
Qualitative		1		2	4	5	5	17
Mixed				1			4	5
Not specified					1			1

Table 5. TOE constructs identified in the literature.

	Identified Construct	Source
T	Compatibility (or technology compatibility, standards uncertainty, and interoperability)	[75,96,104,105,116,119,125,127,141,153]
	Complexity	[75,84,96,107,115,119,132,141,153]
	Relative advantage (or technology perceived benefits) including operational efficiency, security, scalability, ease of use, cost saving, trust, and trialability	[74,75,84,96,101,105,107,109,114–116,122,123,125,127,132,133,140,141,153]
O	Management Support (or higher authority/management support and internal leadership)	[96,105,107,109,114–116,122,123,127,153]
	Organizational readiness (or organizational innovativeness) including organizational structure, culture, finance, flexibility, and technology readiness (or, information technology resources) including infrastructure facility and suitable application	[75,76,96,101,105,109,119,129,132,133,153,154]
	Absorptive capability (or organizational learning capability and knowledge absorption capability)	[75,114,116,123,140,141,153]
	Financial Resources (or cost of obtaining and implementing blockchain and cost/monetary concerns/resources)	[84,96,104,105,107,109,114,116,127,132,133,153]
	Firm size	[105,133,141]
E	Competitive pressure (or competitive intensity, competition, competitor pressure, and rivalry pressure)	[75,84,94,105,115,122,123,127,141,149]
	Trading partners' pressure (or trading partners' readiness, partner readiness, and partner pressure)	[75,94,105,109,116,140,149,153]
	Government policy and support including information technology policy and regulations (or regulatory pressure and regulatory environment)	[75,76,101,104,105,107,115,123,127,141,153]
	Stakeholders' cooperation (or supply chain cooperation, interpersonal connections, trust, external support, environmental support, and knowledge sharing)	[83,101,107,115,116,122,127,132,133]
	Vendor support	[96,153]

In Table 5, for the T context, compatibility is defined as the "degree to which innovation fits with the potential adopters' existing values, previous practices, and current needs" [157]; complexity refers to the "degree to which an innovation is perceived to be relatively difficult to understand and use" [157]; the relative advantage is the "degree to which an innovation is perceived as being better than the idea it supersedes" [158], including the benefits brought about by blockchain technology such as traceability and cost saving [74].

For the O context, management support is the extent to which the management of an organization supports adopting a technology. Organizational readiness is the availability of an organization's resources used to adopt a technology [103]. This includes technology readiness which is related to technology resources (e.g., technology infrastructure, the software required, and employees' technology knowledge and skills) of an organization, including know-how and culture [159]. It is unclear in the literature about the categorization of the construct of technology readiness. Some scholars (e.g., Tasnim et al. [149]) categorize technology readiness into the T context while some other scholars (e.g., Deng et al. [107]) put technology readiness into the O context. As technology readiness involves the use of an organization's resources (e.g., premises for building technology infrastructure and organization structure's technology expertise), technology readiness should be classified into the O context. Absorptive capability is an organization's "ability to recognize the value of new information, assimilate it, and apply it to commercial ends" [160]. Financial resources are the costs used by an organization to implement a technology. Prior studies found that large firms are more willing to adopt new technology [161] as they have a stronger ability to bear risk [109]. In this regard, firm size can affect blockchain adoption. The study by Mendling et al. [162] confirmed that firm size is an essential determinant of blockchain adoption.

For the E context, competitive pressure is an organization's perceived pressure from its competitors, especially the competitors' fast advancing with the advent of new technologies. As found by Queiroz and Wamba [69], blockchain adoption depends on trading partners' willingness and cooperation, resulting in blockchain implementation in an organization due to its trading partners' pressure. As found by Zhu et al. [163], government policy and support can regulate and monitor new technology usage by an organization, which can be a driver or barrier to blockchain adoption [109]. Blockchain technology is a network that requires collaboration among supply chain stakeholders. Therefore, Stakeholders' cooperation influences the use of that technology. Vendor support includes security controls, data availability, user training, and technical support [96], which can positively influence users' intention to adopt a technology [46].

2.3. Critical Review

For research question 4, the literature was critically reviewed to highlight two critical points about blockchain adoption theories or models. First, the individual-level blockchain adoption theories should be combined with the organization-level blockchain adoption theories. In the literature, the TAM and UTAUT were frequently used to explore the factors affecting a supply chain individual's blockchain adoption while TOE was usually used to explore those factors at an organizational level. Although categorizing the TAM and UTAUT at the individual level and TOE at the organization level is a general practice in the literature, these two-level theories were applied at an individual level, as the surveys and interviews were conducted to obtain perceptions from an individual perspective. Also, the integration of the organization-level theory and the individual-level theory facilitates the gathering of better views on blockchain adoption as an individual may also be concerned about organizational elements (e.g., management support, organizational readiness, knowledge absorption capability, and financial resources) while an organization may also have a view of individual components (e.g., performance expectancy, effort expectancy, and social influence). Moreover, combining theories can achieve a better understanding of the technology adoption phenomenon [164]. Therefore, unifying the individual-level theory and the organization-level theory is feasible.

Second, the TAM, UTAUT, and TOE are frequently used in the literature, but little attention has been paid to whether blockchain technology fits the users' tasks in understanding blockchain adoption in the supply chain. Among the technology adoption theories, TTF considers whether a technology fits the tasks to be performed [34]. It was found in the literature that only two studies (i.e., Refs. [89,145]) involved the use of TTF. TTF should be applied as the mere acceptance and utilization of blockchain technology as TAM and UTAUT cannot guarantee better performance in supply chain management. For example, users cannot perform computations well with the use of a word processing app as the capabilities and features of the word processor do not fit the computation tasks. TTF theorizes that task characteristics (TaC) and technology characteristics (TeC) determine the task–technology fit (TTF) construct, which reflects the extent to which the technology fits the task. The TTF construct in turn leads to the user's actual usage (AU) of that technology and affects the user's task performance expectancy (PE). Figure 4 shows the constructs and the influences, as indicated by the arrows, among these constructs in TTF.

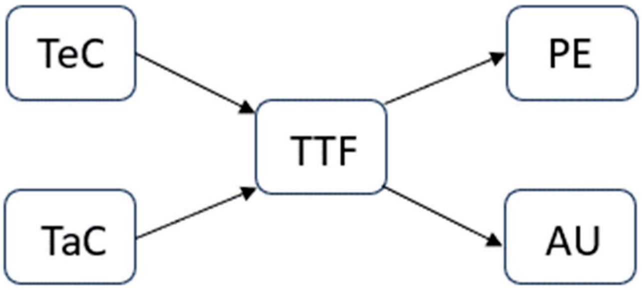

Figure 4. Goodhue and Thompson's [34] TTF.

Furthermore, this review sheds light on a critical issue regarding research design in the literature. Most of the previous studies performed quantitative research such as surveys and quantitative analyses while some previous studies adopted a qualitative approach such as interviews and qualitative analyses. Few studies used a research design that employed mixed methods, which combines and integrates a quantitative approach and a qualitative approach into a single research design.

Mixed methods are recommended for three reasons. First, the mixing of a quantitative method and a quantitative method exhibits the benefits of both methods—the weakness of generalizing the findings from the data of a smaller sample size in a qualitative method can be compensated by the findings from the data of a larger sample size in a quantitative method while the problem of obtaining detailed explanations from a larger sample size in the quantitative method can be solved by the analytical findings of the in-depth interview transcripts from a smaller sample size in the qualitative method. Most of the previous studies on blockchain adoption in the supply chain used a quantitative method in which there is difficulty in explaining the quantitative results. For example, as the empirical research by Queiroz and Wamba [69] found different effects of factors on blockchain adoption in different countries (i.e., India and the USA), a qualitative method could be integrated into this study to explore explanations of the cultural differences as well as environmental and political factors pertaining to blockchain adoption in the supply chain in different countries.

Second, qualitative approaches can provide more insights into the cause–effect relationships found by quantitative approaches [16] and confirm the factors for blockchain adoption in the supply chain found using quantitative approaches. It was found from the literature that many studies have explored the drivers of blockchain adoption in the supply chain while some other studies (i.e., the studies by Kumar Bhardwaj et al. [96], Agrawal et al. [104], Oguntegbe et al. [117], and Yadav et al. [154]) have explored the barriers to blockchain adoption in the supply chain. The constructs in the commonly used the TAM and UTAUT were usually operationalized and measured with the Likert scale using a quantitative method in the literature. For example, a construct in UTAUT was measured with a 5-point Likert scale (5 means strongly agree, 4 means agree, 3 means neutral, 2 means disagree, and 1 means strongly disagree); then, the options 1 and 2 for a construct in UTAUT can mean that the construct is a driver with less effect, no effect, or a barrier to technology adoption. Therefore, a qualitative interview could be conducted to confirm the cause–effect relationship and determine whether the construct represents a factor, no effect, or a barrier. Malik et al. [75] used interviews to confirm the positive (i.e., driver), unsure, and negative (i.e., barrier) impact of the TOE constructs.

Third, a qualitative approach can be used to explore the potential factors for determining TOE constructs for a quantitative approach to measurement. As the TOE framework allows for flexibility in setting a construct in the T, O, or E context and operationalizing the construct as a driver or barrier, content analyses of the in-depth interviews or supply chain documents can help to identify the potential factors for setting TOE constructs in the TOE-TTF-UTAUT model.

Moreover, as the previous studies related to blockchain adoption models investigated the factors on or barriers to blockchain adoption from the respondents' perspectives, the findings of these studies depend highly on the respondents' understanding of blockchain features. As noted from the literature review, many of these previous studies did not specify any attempt to understand how the respondents understood the blockchain features.

3. Discussions and Implications

To explore the antecedents of blockchain adoption in supply chains, UTAUT was considered since it was developed as a modified version through review and consolidation of some other models including the TAM. Having known that the blockchain adoption model should examine whether blockchain technology fits the users' tasks, TTF was integrated into the blockchain adoption model. With reference to the models related to TTF integration presented by Marikyan and Papagiannidis [165], the TTF-UTAUT model was formulated, as shown in Figure 5 in which PE and AU are common constructs in both TTF and UTAUT, TeC, TaC, and TTF are constructs only in TTF, and EE, BI, SI, and EE are constructs only in UTAUT. Also, there is an influence of TeC on EE as technology characteristics such as user interface can affect a user's perceived use of the technology. Therefore, the influence of TeC on EE was added to Figure 5.

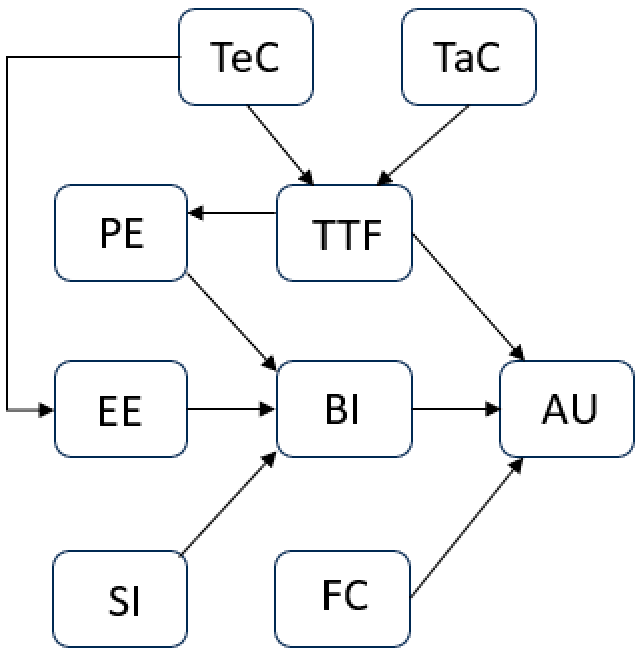

Figure 5. TTF-UTAUT model.

When considering the integration of TOE and TTF-UTUAT, some similar constructs between TOE and TTF-UTAUT were noted. As shown in Figure 6, the constructs in the T context are similar to TeC, the constructs in the O context can be regarded as FC, and SI is a part (or subset) of the E context. Guan et al.'s [133] proposed supply chain factors are equivalent to TaC. In these regards, a new TOE-TTF-UTAUT model, as shown in Figure 6, was formed for the exploration of the antecedents of blockchain adoption in supply chains. The dashed boxes labeled with supply chain task context, T context, O context, and E context indicate that the constructs inside these boxes are not fixed. Those constructs can be determined and changed under different cases (e.g., different users, different organizations, or different situations at different stages).

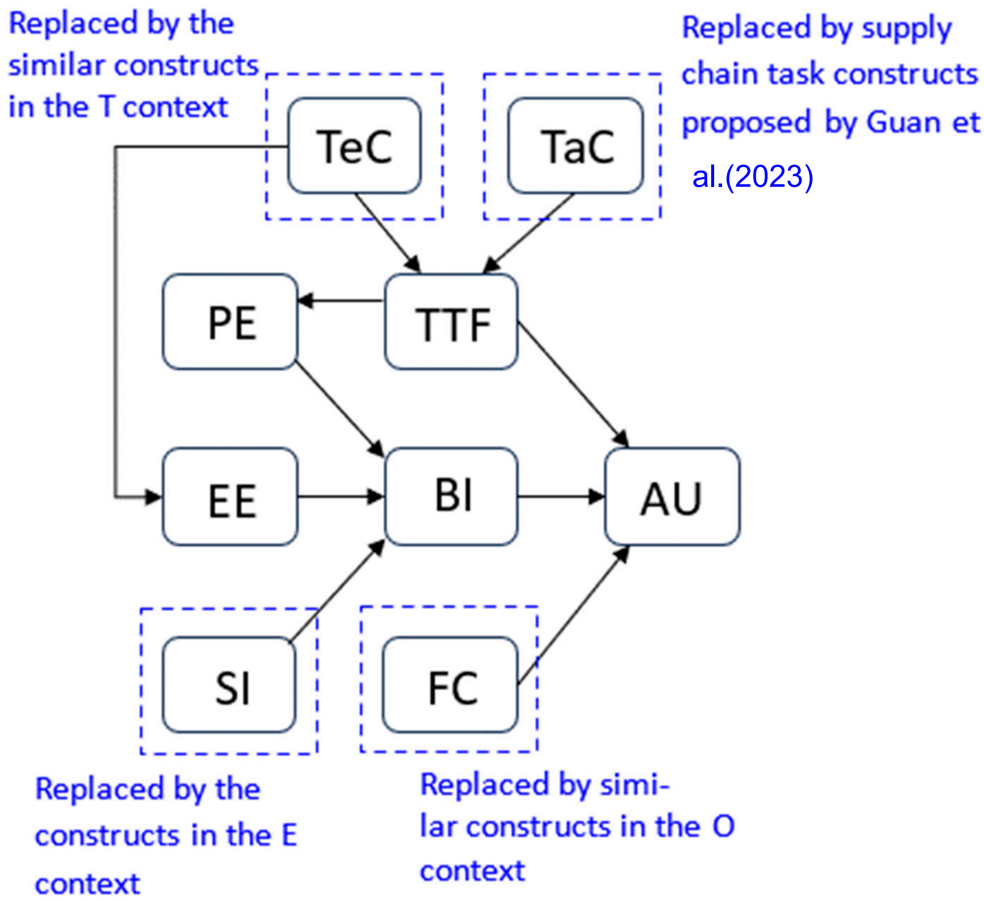

Figure 6. Integrating TOE into TTF-UTAUT [133].

In line with the findings from AlShamsi et al. [16], most of the previous studies depended on the views of management, experts, and consultants at an organizational level. The constructs set in the TOE-TTF-UTUAT model in Figure 7 were based on an organizational perspective. As the TOE-TTF-UTAUT model can be applied at different levels, the individual users' perspectives should also be considered by using a qualitative approach using interviews with the supply chain stakeholders, analyses of the interview transcripts and the supply chain documents, and a literature review on TOE constructs. The supply chain task constructs can also be identified using this qualitative approach.

When adopting the TOE-TTF-UTAUT model in a study, first, seminars on blockchain applications and their features for participants can be organized to ensure that the participants understand the blockchain features. Right after the seminars, two phases of research using mixed methods can be carried out. In the first phase, Creswell and Gutterman's [166] exploratory sequential design of mixed methods can be performed. In this design, a qualitative approach is followed by a quantitative approach. For the study on blockchain adoption in supply chains, once the TOE constructs and the supply chain task constructs, which are like the constructs in the dashed boxes in Figure 7, are determined using a qualitative approach and integrated into the TOE-TTF-UTAUT model, a quantitative approach using a survey and quantitative analyses can be conducted to investigate the factors affecting blockchain adoption in supply chains.

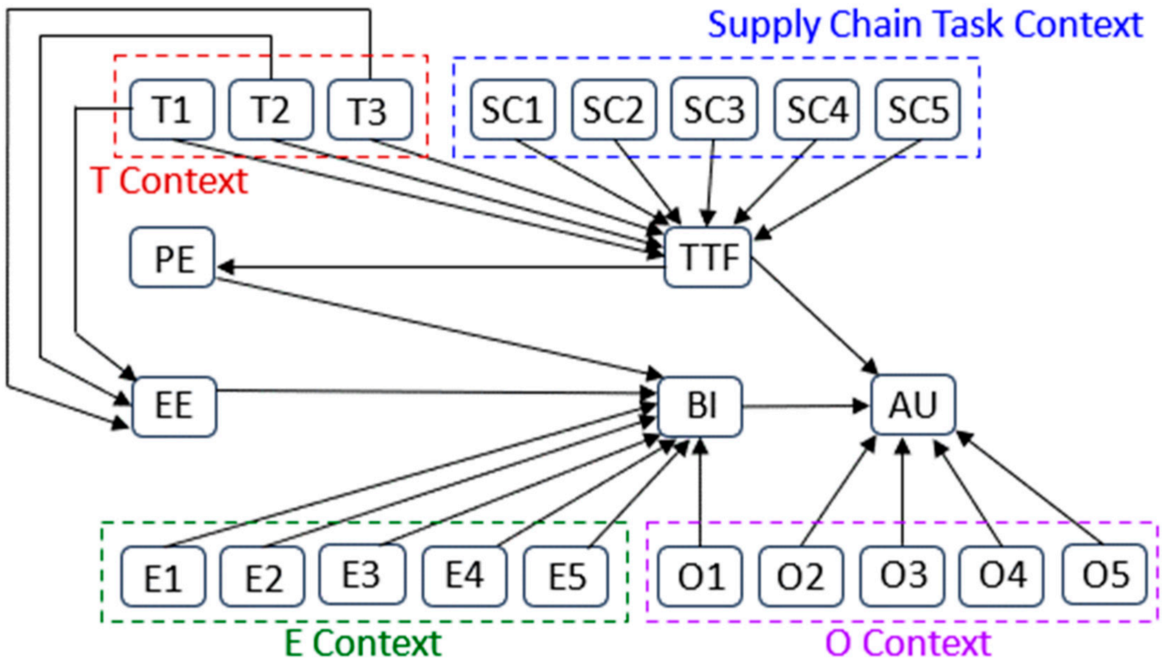

Figure 7. TOE-TTF-UTAUT model.

In Figure 7, the T context contains compatibility (T1), complexity (T2), and relative advantage (T3). In addition, the relevant characteristics of blockchain technology such as shareability, immutability, traceability, and transparency should be incorporated into T3 as a relative advantage. With the use of these measurement items for the blockchain features, whether a blockchain operation such as sharing a replica of a transaction among the involved supply chain stakeholders in the blockchain network fits the stakeholders' task requirements is evaluated. The O context contains management support (O1), absorptive capability (O2), organizational readiness (O3), financial resources (O4), and firm size (O5). The E context contains competitive pressure (E1), trading partners' pressure (E2), government policy and support (E3), stakeholders' cooperation (E4), and vendor support (E5).

In the second phase, Creswell and Gutterman's [166] explanatory sequential design of mixed methods, in which a quantitative approach is followed by a qualitative approach, is used. In this design, the findings from the quantitative approach in the first phase are used and reviewed for follow-up via qualitative interviews to obtain explanations. After that, both the quantitative and qualitative findings in this second phase can be used for triangulation. This proposed research of mixed methods using exploratory sequential design followed by explanatory sequential design is presented in Figure 8.

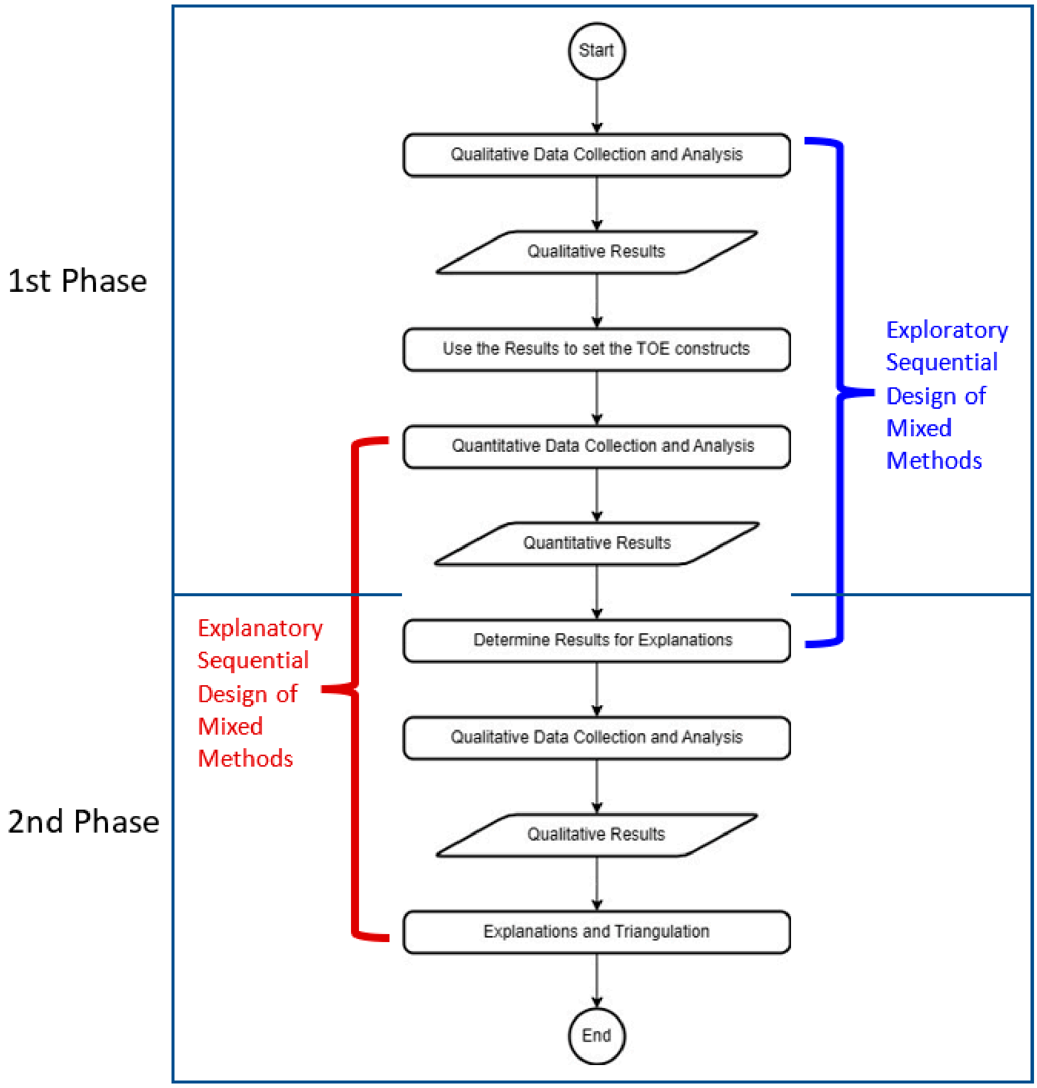

Figure 8. The proposed research of mixed methods.

4. Concluding Remarks and Future Work

As observed from the critical literature review on antecedents of blockchain adoption in supply chains, TAM, TOE, and UTAUT are commonly used, but these models did not consider the important issue of whether blockchain technology fits the supply chain tasks. Also, the literature has paid little attention to this technology fit issue, as only two previous studies involved the use of TTF which considers whether a technology fits the tasks. Moreover, most of the previous studies distinguish organization-level TOE from individual-level UTAUT. In these regards, insights into exploration of a more universal approach to investigate factors that influence supply chain stakeholders' blockchain adoption were obtained. The insights include the suitability of incorporating TTF into a blockchain adoption model, the possibility of combining the organization-level technology adoption theory with the individual-level technology adoption theory, and the applicability of a more appropriate conceptual research design using a mixed method.

Significantly, for future research directions on blockchain adoption in the supply chain, this review study provides a recommendation that includes the new unified technology adoption model, namely, TOE-TTF-UTAUT, and the research design using mixed methods for the exploration of the antecedents of blockchain adoption in supply chains. As the TOE-TTF-UTAUT model contains theories targeted at different levels (i.e., organization level and individual level), the TOE-TTF-UTAUT model is applicable to any level in an organization to have a broader view for understanding blockchain adoption in the supply chain. The TOE-TTF-UTAUT model also contains a task–technology fit component which is more appropriate for the study of technology adoption. For the application of the TOE-TTF-UTAUT model, the proposed research involving mixed methods using exploratory sequential design followed by explanatory sequential design is suitable for setting TOE and task constructs and exploring factors affecting technology adoption.

This study can be extended in three ways. First, the Scopus search tool was mainly used in this study. This review study can be extended to search for any relevant studies that may be found by other search engines (e.g., Emerald, IEEE, MAPI, Springer, and Web of Science). Second, this study reviewed previous studies written in English only. For better coverage of the relevant literature, studies in other languages should also be explored. Third, the TOE-TTF-UTAUT model proposed in this study is a conceptual model, further studies are required to validate the constructs in the TOE-TTF-UTAUT model.

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Abbreviations

Abbreviations used in this article are shown as follows:

AHP	Analytical Hierarchy Process
AU	Actual Usage
BI	Behavioral Intention
BRT	Behavioral Reasoning Theory
CPT	Cumulative Prospect Theory
DEMATEL	Decision-Making Trial and Evaluation Laboratory
DOI	Diffusion of Innovation
EE	Effort Expectancy
FC	Facilitating Conditions
HFS	Hesitant Fuzzy Set
IDT	Innovation Diffusion Theory
IF	Institutional Framework
IT	Institutional Theory
IRT	Innovation Resistance Theory
ISM	Interpretive Structural Modeling
ISS	Information Systems Success
MICMAC	Cross-Impact Matrix Multiplication Applied to Classification
MM	Motivational Model
MPCU	Model of Personal Computer Utilization
NT	Network Theory
PAT	Principal Agent Theory
PE	Performance Expectancy

PEEST	Political, Economic, Environmental, Social, and Technological
PEOU	Perceived Ease of Use
PFS	Pythagorean Fuzzy Sets
PLS-SEM	Partial Least Squares-Structural Equation Modeling
PU	Perceived Usefulness
RBV	Resource-Based View
RDT	Resource Dependency Theory
SCT	Social Cognitive Theory
SI	Social Influence
SNT	Social Network Theory
TaC	Task Characteristics
TAM	Technology Acceptance Model
TeC	Technology Characteristics
TOE	Technology–Organization–Environment
TPB	Theory of Planned Behavior
TRA	Theory of Reasoned Action
TRI	Technology Readiness Index
TTF	Task–Technology Fit
VIKOR	VlseKriterijumska Optimizcija I Kaompromisno Resenje
UTAUT	Unified Theory of Acceptance and Use of Technology
UTAUT2	Extended UTAUT
WASPA	Weighted Aggregated Sum Product Assessment

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