

Hanafizadeh, Payam; Alipour, Maryam

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Taxonomy of theories for blockchain applications in business and management

Payam Hanafizadeh^{*}, Maryam Alipour

Department of Information Technology and Operations Management, Faculty of Management and Accounting, Allameh Tabataba'i University, West End Hemmat Highway, Dehkadeh-ye-Olympic, Tehran 1489684511, Iran

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ABSTRACT

The rising prominence of blockchain technology has spurred researchers to delve deeper into its applications through the lens of organizational and management theories. Our thematic analysis of blockchain literature reveals examination across five key areas: economic, strategic, operational, behavioral, and implementation considerations, each viewed through various theoretical perspectives. The multifaceted nature of blockchain phenomena necessitates diverse types of theory and research questions. Thus, the unique characteristics within each area stimulate the formulation of inquiries that address a system of research questions about *what, how, why, when, where, what will be, and how to do*. Existing literature predominantly emphasizes explanatory and predictive type of theories, notably expanding research topics such as blockchain adoption behavior. However, this singular focus limits the exploration of diverse reasoning approaches suited to blockchain's complexity. Our study illustrates how different types of theory contribute to understanding each of the identified blockchain application areas. Based on our findings, we propose pertinent questions that highlight the need for varied theoretical frameworks and address specific issues within each application area. Furthermore, we recommend appropriate type of theories to address these questions, fostering a more multi-perspective investigation across the breadth of blockchain-related research topics and areas. By embracing diverse theoretical perspectives, we aim to create a more balanced research landscape, facilitating deeper insights into blockchain phenomena.

1. Introduction

Blockchain technology has increasingly attracted significant interest from management academics and business communities in recent years. While third parties centrally execute transactions, blockchain consensus mechanisms verify business transactions in a decentralized manner (Hughes et al., 2019). The blockchain ledger stores the verified transaction data in a distributed way so that all actors benefit from a high capacity for sharing of business information (Marikyan, Papagiannidis, Rana, & Ranjan, 2022). In addition, blockchain-enabled smart contracts can codify a set of performance expectations (Shermin, 2017). Accordingly, blockchain creates value for business models (BMs), strategies, processes, and management (Sun, Jiang, Jia, & Wang, 2022). However, blockchain also experiences several open challenges, for example regarding high-energy usage, selfish mining, data privacy, and lack of standards (Gad, Mosa, Abualigah, & Abohany, 2022).

In recent years, the literature on both the potentials and challenges of blockchain applications in business and management has been evolving

(Zhou, Zhang, Zhao, Zheng, & Song, 2021). However, due to the novelty of the blockchain domain, so far, most studies have been conceptual and exploratory (Frizzo-Barker et al., 2020). In the literature, such studies have, for example, explored blockchain applications in supply chain management (e.g., Chen, Liu, Yan, Hu, & Shi, 2021), healthcare (e.g., Siyal et al., 2019), banking (e.g., Guo & Liang, 2016), and education (e.g., Chen, Xu, Lu, & Chen, 2018). As blockchain technology evolves, studies are gradually moving away from conceptual explorations toward the use of theories for understanding more deeply blockchain adoption, implementation decisions, and outcomes (Frizzo-Barker et al., 2020; Schmidt & Wagner, 2019). Theories can guide the blockchain studies to formulate fundamental research questions and support data analysis and interpretation of findings (Treiblmaier, 2018). Therefore, using theories to provide higher quality and managerial relevance of results obtained is critical to accelerate the maturity of blockchain applications and related research domains (Hanafizadeh & Alipour, 2024).

In blockchain literature and reviews, the focus on theory application and theory development has been limited. Most reviews have only

^{*} Corresponding author.

E-mail address: hanafizadeh@gmail.com (P. Hanafizadeh).

focused on blockchain applications and trends (e.g., [Casino, Dasaklis, & Patsakis, 2019](#); [Sun et al., 2022](#)). The discourse of some reviews has been centered around both applications and theories in a specific research area of blockchain, but the nexus of theories and themes arising from the literature has not been deeply evaluated (e.g., [Alkhudary, Brusset, & Fenies, 2020](#); [Lei & Ngai, 2023](#)). A few reviews have focused entirely on theories, but have been limited to the supply chain domain (i.e., [Ahmed & MacCarthy, 2022](#); [Kummer, Herold, Dobrovnik, Mikl, & Schäfer, 2020](#); [Zhu, Bai, & Sarkis, 2022](#)). Therefore, there is a lack of a thoughtful evaluation of the literature resulting from theory development to understand the broader applications of blockchain in business and management. Especially, since actual implementations and empirical evidence of blockchain are growing in many industries, the need for a general-domain theory review to guide research questions is intensified. In addition, the existing reviews have overlooked the analysis of the types (forms) of theories used, which directly affect the forms of formulation of both research questions and theoretical statements. In this study, we systematically review the theories that have been used to understand the blockchain application areas and issues in the business and management, regardless of the specific industry and scenario. Indeed, due to the wide scope of blockchain applications, we did not limit the review to a specific business and management research domain. We adopt [Gregor's \(2006\)](#) theory taxonomy to determine which of the 5 types of theory are used in the literature, i.e. analysis, explanation, prediction, explanation and prediction, and design and actions.

[Gregor's \(2006\)](#) taxonomy provides a system of research questions in relation to five types of information system (IS) theory, including “what”, “how”, “why”, “when”, “where”, “what will be” and “how to do”. Each form of research questions, in turn, influences the choice of type of theoretical claims or statements that can be made. Therefore, there is a direct connection between the type of theory, research question and theoretical statement. For example, explanatory theories justify “how” to provide causality (not testable) statements. Nevertheless, in this research, [Gregor's \(2006\)](#) taxonomy permits us to find out what forms of research questions have been addressed, what are missing, and what are the further questions to study blockchain applications, in reference to each of the theory types. We contribute by showing that multiple forms of theory can be used in the blockchain literature, which each of them can provide important research questions and valuable insights on blockchain applications. Indeed, the multidimensional nature of blockchain phenomena requires different types of theory and research question. Otherwise, focusing on a specific type of theory prevents researchers from employing different forms of research questions to distinctively study the blockchain applications. That is why the common types of theory in use are too restrictive, as the body of knowledge and research questions within blockchain domains do not acknowledge the existence of multiple forms of theory. On the contrary, mostly used one type of theory, namely explanatory and predictive theory – that has greatly enlarged the research topics such as blockchain adoption behaviors, relative to others. Hence, we seek to inform researchers to develop existing theories in more varied ways and for a broader set of purposes than is typically recognized, i.e. prevalent type for explaining and predicting. Using different types of theory can provide a more level playing field within the blockchain-related system of research questions and the topics and areas under investigation.

So far, researchers have employed [Gregor's \(2006\)](#) taxonomy to distinguish the types of theory used in research domains such as information privacy ([Bélanger & Crossler, 2011](#)), information technology (IT)-associated entrepreneurship ([Steininger, 2019](#)), and supply chain innovation ([Wong & Ngai, 2019](#)). In the domain of blockchain-enabled supply chains, [Treiblmaier \(2018\)](#) proposed different forms of research questions related to 4 widely used supply chain theories using [Gregor's \(2006\)](#) taxonomy. To the best of our knowledge, there is a gap with regard to a review covering the blockchain applications in the overall business and management research, particularly in reference to [Gregor's \(2006\)](#) taxonomy. Despite the recognition of the need to borrow

appropriate theory in blockchain domains ([Hanafizadeh & Alipour, 2024](#)); there is no discussion in blockchain literature of what forms of theory contributions to knowledge can take. This study seeks to fill this gap through finding answer to the following research question: *What is the taxonomy of theories to study blockchain applications in business and management?*

To answer, we thematically show that 46 theories were used in 91 blockchain articles; and 5 economic, strategic, operational, behavioral, and implementation consideration areas of blockchain applications have been explored. We delve into 46 theories to find out which of [Gregor's \(2006\)](#) theory types have contributed to the understanding of above five blockchain application areas. Doing so, we present the overlooked or under-researched issues related to blockchain application areas and show which theory types of [Gregor's \(2006\)](#) taxonomy need more attention. Accordingly, we propose several questions to show which types of [Gregor's \(2006\)](#) theory taxonomy and which issues of blockchain applications deserve further research. In addition, we propose theories to address research questions. These questions can contribute to successful theory-driven blockchain research and increase the managerial relevance of their results.

2. Literature review

Using the following search string, we found 70 studies that 11 of which systematically reviewed the theories used in different subject areas of the blockchain literature: “((TITLE (blockchain) OR TITLE ("smart contract") OR TITLE (Ethereum)) AND TITLE-ABS-KEY ("literature review") AND TITLE-ABS-KEY ("Theoretical development" OR "theorizing" OR "theory application" OR "theories" OR "theoretical framework" OR "theoretical perspectives" OR "theory-driven approach" OR "theory-driven research" OR "theoretical approach" OR "theoretical underpinnings")) AND PUBYEAR < 2024 AND (LIMIT-TO (SRCYPE,"j")) AND (LIMIT-TO (DOCTYPE,"ar") OR LIMIT-TO (DOCTYPE,"re")) AND (LIMIT-TO (LANGUAGE,"English"))”. The studies are classified as English articles or reviews in Scopus-indexed peer-reviewed journals until the end of 2023. [Tables 1 and 2](#) provide quantitative and qualitative overviews of the previous review articles, respectively; the positioning of this paper is also shown.

[Table 1](#) shows how many theories have been analyzed in the review articles. The number of theories is also specified according to their perspective in understanding blockchain phenomena. Except [Sapra et al.'s \(2023\)](#) article, most of the reviewed theories have been used to understand the organizational and managerial concepts and outcomes related to blockchain. The literature reviews showed that many traditional theoretical concepts in the field of organization and management (e.g., decentralization, democratized trust, and sustainable practices) are well realized by blockchain properties ([Hanafizadeh & Alipour, 2024](#)). Thus, theories with management and organizational perspectives, especially those with an inter-organizational level of analysis, can help examine the implications of blockchain use in business and management. Obviously, as blockchain matures further, academic attention will shift from technology conceptualization and architecture to understanding related organizational and managerial concepts. Accordingly, in this paper, we intended to focus completely on theories with organizational and managerial perspectives—comparatively with a larger number (i.e., 46 theories) than previous reviews. Nevertheless, we excluded two theoretical perspectives from our review. First, we did not consider the theories used in the subject areas of engineering, computer science, and mathematics. Thus, theories that are mostly used to understand blockchain-related computational, energy usage, economic valuation, and security concepts were excluded. For example, we excluded the zero economic profit theory reviewed by [Sapra et al. \(2023\)](#) to understand what rising prices mean for the network's energy consumption and the theory of purchasing power parity reviewed by [Lei and Ngai \(2023\)](#) to model the token value development. Second, we did not extract theories with analytical modeling characteristics, like chaos

Table 1
A quantitative overview of articles reviewing the theories used in the blockchain literature.

Theory-driven blockchain review studies	Total number of reviewed theories	Theoretical perspectives				
		Management and organizational perspectives	Computational, economic valuation, and security perspectives	Analytical modeling perspectives	Methodological perspectives	Theory building or as a source material of theories
Ahmed and MacCarthy (2022)	17 theories	16	0	0	0	1
Alkhudary et al. (2020)	18 theories	14	2	1	1	0
Bhawna, Gupta, Rai, and Chauhan (2023)	8 theories	7	0	0	0	1
Jain, Singh, Mishra, and Rana (2023)	7 theories	7	0	0	0	0
Kummer et al. (2020)	6 theories	6	0	0	0	0
Lei and Ngai (2023)	59 theories	28	19	5	5	2
Lohmer, Ribeiro da Silva, and Lasch (2022)	11 theories	11	0	0	0	0
Sapra, Shaikh, and Dash (2023)	11 theories	1	9	1	0	0
Singh, Mishra, Gupta, and Mukherjee (2023)	14 theories	14	0	0	0	0
Vu, Ghadge, and Bourlakis (2023)	17 theories	17	0	0	0	0
Zhu et al. (2022)	10 theories*	10	0	0	0	0
This paper	46 theories	46	0	0	0	0

* While Zhu et al. (2022) found a total of 80 theories appearing across blockchain literature in the supply chain domain, the 10 most popular theories were analyzed in depth.

theory, evolutionary game theory, game theory, mean-risk theory, queueing theory, and regret theory. In line with Zhu et al. (2022), we believe that such theories are more appropriate for completing analytical methodological analyses and for methodological evaluation than theory development. Such analytical theory models can be used to methodologically evaluate most of theories with managerial, organizational, computational, valuation, and security perspectives. Among the articles, since Lei and Ngai (2023) and Sapra et al. (2023) have reviewed theories in IS and proof of work (PoW)-based blockchain domains, respectively, they have identified the most theories with computational, valuation, security and analytical modeling perspectives. We also found that two reviews have considered the methodological or conceptual frameworks used in blockchain literature as part of their identified theories, including design science research theory (Lei & Ngai, 2023) and grounded theory (Alkhudary et al., 2020). Other articles, including ours, did not consider the methodological frameworks used in blockchain literature as part of the identified theories; because, such frameworks are a methodology for conducting and designing research. Evaluation of review articles also showed that two reviews also included newly built theories, that is user experiences framework (Lei & Ngai, 2023) and blockchain-based producer-consumer model (Bhawna et al., 2023). Other reviews, including ours, have focused solely on existing theories that have been borrowed, developed, or tested in the blockchain literature. Finally, we did not consider the well-known concepts such as the theory of disintermediation (Lei & Ngai, 2023) and network effect (Ahmed & MacCarthy, 2022) as theories. Such concepts are actually the source material of some existing theories. In general, most of the theories with management and organizational perspectives reviewed in previous articles either have been identified as part of our 46 theories. Others, particularly related to analytical modeling theories, have been proposed as potential theories in Section 6.1. However, among the 46 theories we reviewed, some were not examined in other review articles (e.g., mechanism design theory (MDT), social proof theory (SPT), and trust-based marketing theory (TBMT)).

Table 2 shows the type, focus, method, and contribution of the review articles. First, "Type" includes theory review or a more general review. There are only 3 theory reviews which are centered around the

theories used in blockchain literature (i.e., Ahmed & MacCarthy, 2022; Kummer et al., 2020; Zhu et al., 2022). However, theory classification for blockchain application areas does not exist (i.e., Kummer et al., 2020) or only on the more famous (i.e., Zhu et al., 2022) or applicable theories (i.e., Ahmed and MacCarthy) in a specific research domain. The other 8 articles are more general reviews and focus more on blockchain applications in the domain under investigation rather than theories. Therefore, the 8 review articles are lacking any in-depth assessment of the contributions of theories to understanding blockchain applications. Nevertheless, there is no comprehensive theory review and classification; that is why this article was written.

Second, "Focus" refers to the main forms of systematic literature review, which include domain-based, theory-based, and method-based (Paul & Criado, 2020). Since all previous reviews focused on developing blockchain-related applications or theorizing instead of developing a specific theory (i.e., theory-based) or a specific method (i.e., method-based), they are domain-based. However, they are mostly limited to blockchain domains such as food supply chain (Vu et al., 2023), tourism and hospitality (Jain et al., 2023), and consumer services (Bhawna et al., 2023). Thus, there is no a domain-based review for broader blockchain applications in business and management; our article fills this gap.

Third, "Method" includes sub-forms of a domain-based review: structured theme-based, framework-based, bibliometric, hybrid, and aiming for model/framework development (Paul, Lim, O'Cass, Hao, & Bresciani, 2021). Based on the fifth column of Table 2 (i.e., "Overview of current knowledge"), previous reviews mostly focus on the development of themes such as blockchain's application areas, benefits and challenges, and the theories and methods used. Therefore, most of the reviews are structured theme-based either completely (e.g., Alkhudary et al., 2020) or as part of their hybrid method (e.g., Singh et al., 2023). Some articles rely on established frameworks to guide the review of a blockchain domain and sometimes suggest future research areas. According to "Contribution" sub-columns from Table 2, the frameworks used include: (1) Paul and Benito's (2018) antecedents, decisions, and outcomes (ADO) (i.e., Sapra et al., 2023; Zhu et al., 2022); (2) Paul, Parthasarathy, and Gupta's (2017) theories, contexts, and methods

Table 2
A qualitative overview of articles reviewing the theories used in the blockchain literature.

Sources	Type	Focus	Method	Contributions	
				Overview of current knowledge	Future research directions
Ahmed and MacCarthy (2022)	Theory review	A domain-based review of blockchain literature in supply chain management	Review aiming for framework development	<ul style="list-style-type: none"> – Intra-organizational, inter-organizational, technical, and external environment factors and barriers of blockchain adoption and application – Theories used or proposed 	<p>Developing a framework for theory-driven blockchain research that maps applicable theories to intra-organizational, inter-organizational, technical, and external environment factors and barriers of blockchain application.</p> <p>Proposing nine potential theories.</p> <p>Representing the future research avenues suggested in the reviewed literature</p>
Alkhudary et al. (2020)	A more general review	A domain-based review of blockchain literature in general management and economics	Structured theme-based review	<ul style="list-style-type: none"> – Descriptive quantitative results – Blockchain research areas (i.e., law, economy, and innovation) – Blockchain implementation challenges – Theories used or proposed 	<p>Offering future directions using TCCM framework (theory, characteristics, contexts, and methods)</p>
Bhawna et al. (2023)	A more general review	A domain-based review of blockchain literature in consumer services	Hybrid review: bibliometric and framework-based reviews	<ul style="list-style-type: none"> – Current publication trends – Most impactful publications – Trend topics of blockchain – Blockchain advantages and challenges – Most used theories, characteristics, contexts, and methods (Using TCCM framework) 	<p>Offering future directions using TCCM framework (theory, characteristics, contexts, and methods)</p>
Jain et al. (2023)	A more general review	A domain-based review of blockchain literature in tourism and hospitality industry	Hybrid review: structured theme-based review and framework-based review	<ul style="list-style-type: none"> – Research trends (methodological classification) – Blockchain application areas – Theories used – Blockchain benefits and challenges – Theories used – Associated investigation opportunities per theory used 	<p>Offering propositions on blockchain adoption enablers and challenges.</p> <p>Offering future directions using TCM framework.</p> <p>Proposing four potential theories.</p> <p>Offering future research questions for each theory used in the literature</p>
Kummer et al. (2020)	Theory review	A domain-based review of blockchain literature in logistics and supply chain management	Structured theme-based review	<ul style="list-style-type: none"> – Descriptive quantitative results – Research paradigms – Theories and methods used – Interactions with other technologies – Blockchain-based innovations – Forms of blockchain – Application sectors – Phases of blockchain innovations 	<p>Offering future research questions on blockchain related research paradigm, theories, system design, blockchain adoption, blockchain implementation, and blockchain impacts.</p> <p>Proposing four potential theories that have not been applied in the research context.</p>
Lei and Ngai (2023)	A more general review	A domain-based review of blockchain literature in IS domain	Structured theme-based review	<ul style="list-style-type: none"> – Descriptive quantitative results – Research and industry focus – Theories and methods used – Business areas addressed – Technology interfaces – Blockchain potentials and barriers – Adoption status – Consensus mechanisms used – Platforms used – Network configurations 	<p>Offering future research questions using PESTLE-categorized areas (political, economic, social, technological, legal, and environment)</p>
Lohmer et al. (2022)	A more general review	A domain-based review of blockchain literature in operations and supply chain management	Structured theme-based review	<ul style="list-style-type: none"> – Descriptive quantitative results – Theories and methods used – Business areas addressed – Technology interfaces – Blockchain potentials and barriers – Adoption status – Consensus mechanisms used – Platforms used – Network configurations 	<p>Offering future research questions using TCM framework</p> <p>Proposing two potential theories that have not been applied in the research context.</p>
Sapra et al. (2023)	A more general review	A domain-based review of PoW-based blockchain applications' environmental consequences	Hybrid review: integrating frameworks to provide directions for future research	<ul style="list-style-type: none"> – Descriptive quantitative results – Theories, contexts, and methods used to study the relationships between PoW-based blockchain applications and the environment (Using TCM framework) – Antecedents, decisions, and outcomes of relationships between PoW-based blockchain applications and the environment (Using ADO framework) 	<p>Offering future research questions using TCM framework</p> <p>Proposing two potential theories that have not been applied in the research context.</p>
Singh et al. (2023)	A more general review	A domain-based review of blockchain literature for secured and resilient supply chain	Hybrid review: structured theme-based review and framework-based review	<ul style="list-style-type: none"> – Descriptive quantitative results – Theories used – Blockchain adoption and applications – Blockchain role in dis/re-intermediation – Blockchain challenges and benefits – Descriptive quantitative results – Blockchain implementation process – Blockchain drivers and barriers – Blockchain applications – Theories and methods used 	<p>Offering future research questions using TCM framework</p> <p>Proposing two potential theories that have not been applied in the research context.</p>
Vu et al. (2023)	A more general review	A domain-based review of blockchain literature in food supply chains	Structured theme-based review	<ul style="list-style-type: none"> – Descriptive quantitative results – Blockchain implementation process – Blockchain drivers and barriers – Blockchain applications – Theories and methods used 	<p>Offering future research directions on blockchain related empirical work, scalability issues, challenges, incentivization, sustainability application, and regulations</p>
Zhu et al. (2022)	Theory review	A domain-based review of blockchain literature in supply chain operations including logistics and transportation	Hybrid review: structured theme-based review and framework-based review	<ul style="list-style-type: none"> – Descriptive quantitative results – Theories used – Blockchain-related antecedents, decisions, and outcomes (Using ADO framework) 	<p>Framing future research questions for each theory identified using ADO framework.</p> <p>Proposing various potential theories that have not been applied in the research context.</p>

(continued on next page)

Table 2 (continued)

Sources	Type	Focus	Method	Contributions	
				Overview of current knowledge	Future research directions
This paper	Theory review	A domain-based review of blockchain literature in business and management (a general-domain review)	Hybrid review: structured theme-based review and framework-based review	<ul style="list-style-type: none"> – Framing of the theories used in the ADO framework – Descriptive quantitative results – Theories used – Blockchain-related application areas (i.e., economic, strategic, operational, behavioral, and implementation considerations) and related issues – Gregor's (2006) theory types used – Narrative with Gregor's (2006) taxonomy to review current status of blockchain application areas and issues under the influences of used theories 	Narrative with Gregor's (2006) taxonomy for setting future research questions on issues related to each of the 5 blockchain application areas identified and proposing some applicable theories to address the questions posed.

(TCM) (i.e., Jain et al., 2023; Sapra et al., 2023; Singh et al., 2023); (3) Paul and Rosado-Serrano's (2019) theories, constructs, characteristics, and methods (TCCM) (i.e., Bhawna et al., 2023) and (4) Aguilar's (1967) PESTLE-categorized political, economic, social, technological, legal, and environmental areas (i.e., Sapra et al., 2023). Although reviews have identified some structured themes (including theories) or used the framework to structure blockchain research, they have not adequately clarified the application of the theories, especially in relation to other structured themes or dimensions of the framework. Of course, Zhu et al. (2022) using ADO framework referred blockchain-related research areas to theories, but this was limited to 10 famous theories - not all theories used. Furthermore, none of the reviews focused on the types (forms) of theory to determine the current situations and gaps in the system of research questions. Only Zhu et al. (2022) briefly mentioned the possibilities for expanding theorizing from explanatory theory type to potentially emancipatory in blockchain literature. Overall, there is a lack of reviewing the types (forms) of all theories used in reference to the blockchain application areas under investigation. This paper fills this gap by adopting Gregor's (2006) theory taxonomy in integration with structured themes related to the theories in use and the areas of blockchain applications under investigation.

Finally, the "Future research directions" shows that reviews provide recommendations by offering propositions (Jain et al., 2023; Lohmer et al., 2022), potential theories (e.g., Ahmed & MacCarthy, 2022; Zhu et al., 2022; this paper), a comprehensive framework for theory-driven research (Ahmed & MacCarthy, 2022), and new research areas (e.g., Alkhudary et al., 2020; Kummer et al., 2020) especially using established frameworks (e.g., Bhawna et al., 2023; Jain et al., 2023; this paper). However, most of the previous recommendations have centered on blockchain applications, without reference to related applicable theories. Also, they did not identify what the opportunity is in theorizing with different types of theory. We address these gaps in this study.

3. Theoretical foundation: Gregor's (2006) theory taxonomy

According to Gregor (2006), theories aim to describe, explain, and enhance understanding of the world and, in some cases, to provide predictions of what will happen in the future and to give a basis for intervention and action. She showed that three important components common to theories are constructs, statements of relationship, and scope. Constructs are abstract and conceptual units of a phenomenon that can be operationalized by the variables that are defined for them in the empirical world (Bacharach, 1989; Whetten, 1989). Statements of relationship show relationships among the constructs. Gregor (2006) showed that the statements of relationship are of three types: causal explanations, testable propositions (hypotheses), and prescriptive statements. Causal explanations are the statements of relationship

between constructs that show causal reasoning (Miles, 2012). Hypotheses are measurable propositions predicting the relationships among variables (Bacharach, 1989). Prescriptive statements specify how people can construct an artifact. Finally, the scope is specified by the theoretical assumptions limiting the generalizability of theories (Busse, Kach, & Wagner, 2017). As assumptions are tautological statements (Hanafizadeh, Hatami Lankarani, & Nikou, 2022) and formulate the meaning and function of constructs and relationships, they are the most determining component in theory selectivity, especially for emerging technology-oriented contexts, such as blockchain (Hanafizadeh & Alipour, 2024).

Gregor (2006) proposed a taxonomy that distinguishes five interrelated types of theory in ISs. The taxonomy classifies theories with respect to the degree and manner in which they address four central purposes of theory: analysis, explanation, prediction, and prescription. The judgement needed to determine what the primary purpose of a theory is and to which theory type it belongs to depends on the nature of statements of relationship. In *theory for analyzing (Type I)*, no causal, testable or prescriptive statements of relationship between constructs are specified. Type I focuses on finding the answer to the "What?" question. It structures the ambiguous nature of an unknown phenomenon into meaningful categories. Type I is the most basic type of theory that is necessary for the development of all other types of theory. The *theory for explaining (Type II)* is recognized by statements of relationship that are causal explanations. It focuses on explaining the causal reasoning among the constructs, without predicting future events. Thus, Type II presents reasons about "What?", "Why?", "How?", "When?" and "Where?" to understand the phenomenon. In the *theory for predicting (Type III)*, the statements of relationship are the testable propositions (hypotheses) about future events, without providing underlying justifications for causality. It answers "What?" and "What will be?" questions. In *theory for explaining and predicting (Type IV)*, the statements of relationship are both causal explanations and testable propositions (hypotheses). It says "What?", "Why?", "How?", "When?", "Where?", and "What will be?". Finally, the *theory for design and action (Type V)* gives prescriptive statements of relationships. Type V specifies how to design, implement, evaluate, and manage an IT artifact by prescribing key processes, guidelines, and techniques. It reasons about "How to do something?"

4. Methodology

This study seeks to determine how each of the types of Gregor's (2006) theory taxonomy addressed the areas and issues related to blockchain applications in the literature, and what the associated gaps and future directions are. To this aim, a systematic literature review approach can provide in-depth coverage of extant scattered literature on the research topic, synthesize previous studies, identify knowledge gaps, and signal future research directions (Paul & Criado, 2020). The main

approaches of systematic literature review include domain-based, theory-based, and method-based (Paul et al., 2021). Because we sought to develop theorizing in blockchain-related research topics and areas, a domain-based review approach was adopted. Actually, a hybrid domain review was conducted by integrating the tenets of structured theme- and framework-based reviews. According to Paul et al. (2021), the use of frameworks is more useful and impactful than other sub-forms of domain-based reviews due to the delivery of the highest level of clarity and coverage. There are a number of grounds that Gregor's (2006) framework that classifies IS theory, can form a sound framework-based review for theory taxonomization in blockchain domains. First, Gregor's (2006) taxonomy has been developed on the disciplinary areas of the natural science, social science, and science of the artificial, which form the knowledge body of ITs such as blockchain. Hence, according to Gregor (2006), five types of theory can be used in the fields with a body of knowledge similar to IS, especially regarding the intersection of human and machine behavior. Second, Gregor's (2006) taxonomy relies on the purposes of a theory, which are seen as of primary importance and initial structural ground over other attributes to distinguish different types of theory. Hence, focusing on the purpose-related classifier for theory taxonomization prevents us from being dazzled by other criteria, especially starting to determine theory types in emerging fields like blockchain. For example, Gregor's (2006) taxonomy provides a simpler guide to theory classification than Sandberg and Alvesson's (2021) typology, which uses 6 other criteria (e.g., empirics and intellectual insight) in addition to theoretical purpose to distinguish among types of theory. However, herein, while Gregor's (2006) taxonomy classifies theory in the discipline of ISs, Sandberg and Alvesson's (2021) typology are presented within management and organization studies and social science. Therefore, another reason to justify the selection of Gregor's (2006) taxonomy is that IT artifacts - such as blockchain technology - are the core subject matter of IS discipline. Finally,

adopting Gregor's (2006) taxonomy, we can find out what types of questions from the theory have been addressed and can be considered. These forms of questions are relating to the meaning and structural nature of theory that are overlooked in comparison with questions relating to blockchain applications and trends.

The research design in this study is as follows. We first identified relevant literature by following a data collection procedure outlined in Section 4.1. Second, we conducted a structured theme-based review in Sections 4.2 and 4.3 to develop the themes emerging from the literature including the theories used and which blockchain application areas and issues have been evaluated under the influence of the theories. We captured the research question(s) related to each theory applied in the literature to explore blockchain applications. These questions are presented in Tables 4 to 8 to illustrate the purpose of using the theories in the literature. Third, in Section 4.4, we conducted a framework-based review focusing on Gregor's (2006) five types of theory to find out what purpose each theory has been used in the blockchain literature. Fourth, the developed themes - i.e., theories and the blockchain application areas and issues - related to Gregor's (2006) theory types were reported in Section 5. In this sense, in each of the blockchain application areas, we narrated how theories and based on which of Gregor's (2006) theory types have been used to understand issues related to blockchain—in the last paragraph of Sections 5.1 to 5.5, we outlined what the relevant directions for future research are. The research methodology of this study is shown in Fig. 1.

We synthesized the literature following a descriptive and thematic analysis. Thematic analysis examines the blockchain literature for specific themes arising from the structured theme-based review (i.e., theories and blockchain applications) and framework-based review (i.e., types of Gregor's (2006) theory taxonomy). The descriptive analysis shown in Figs. 2, 3 and 4 captures the frequency of these themes.

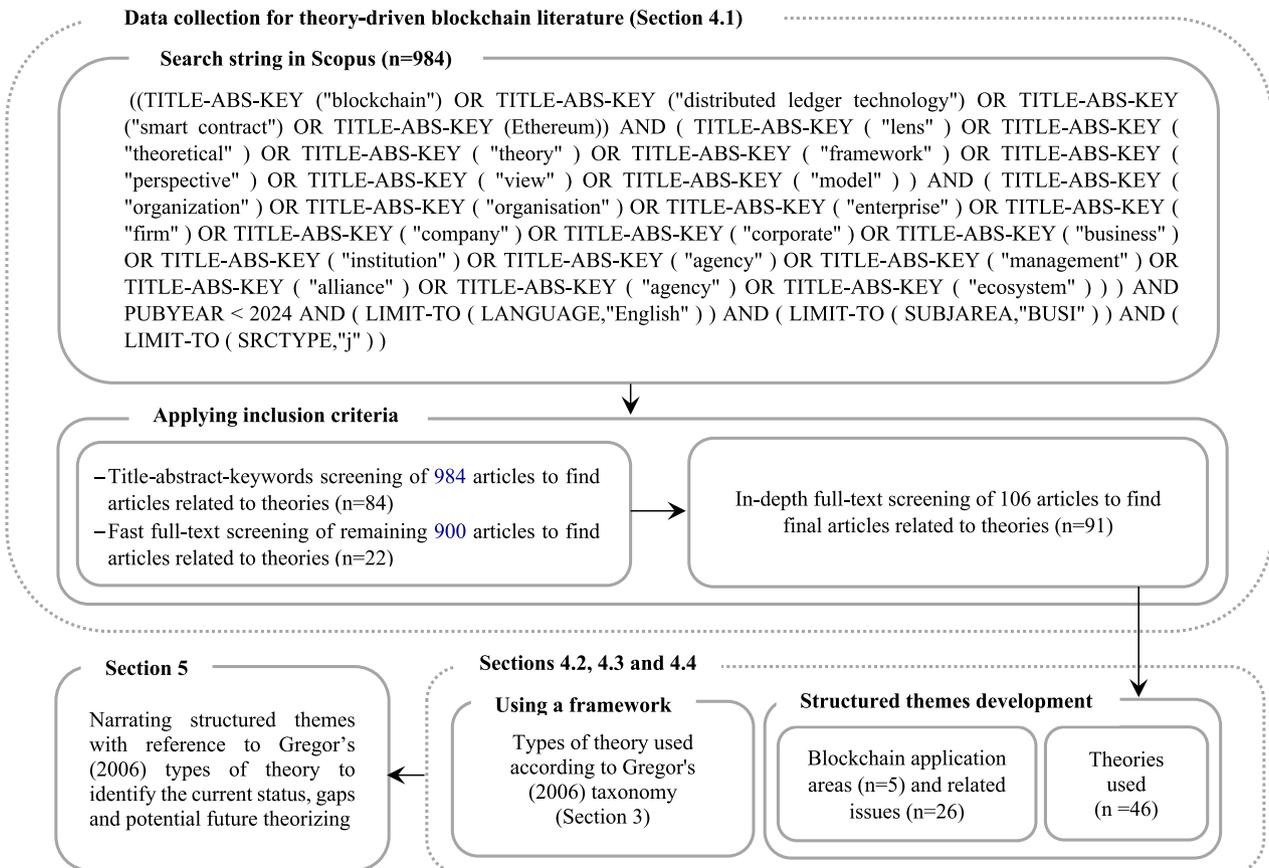


Fig. 1. Research methodology.

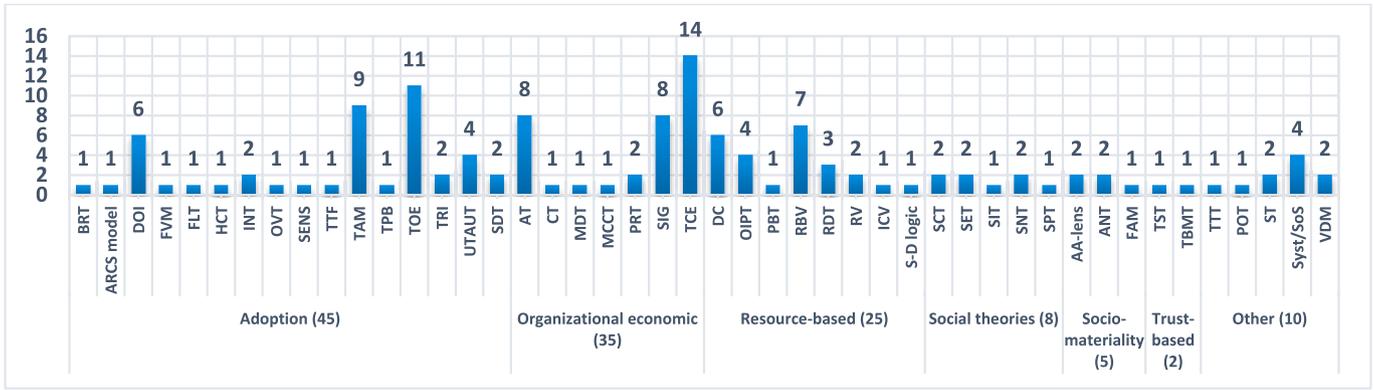


Fig. 2. A summary of the theories used and their frequency of application.

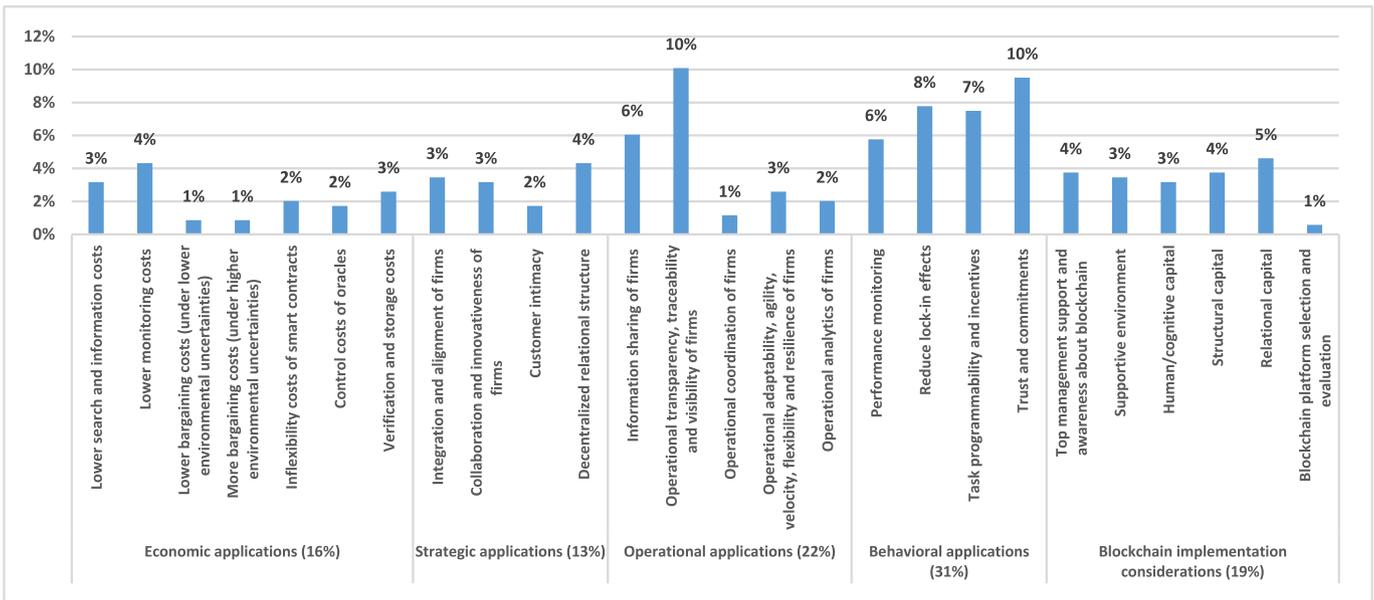


Fig. 3. A summary of blockchain-related application areas and issues studied by theories (The percentages are calculated in the total of all blockchain articles).

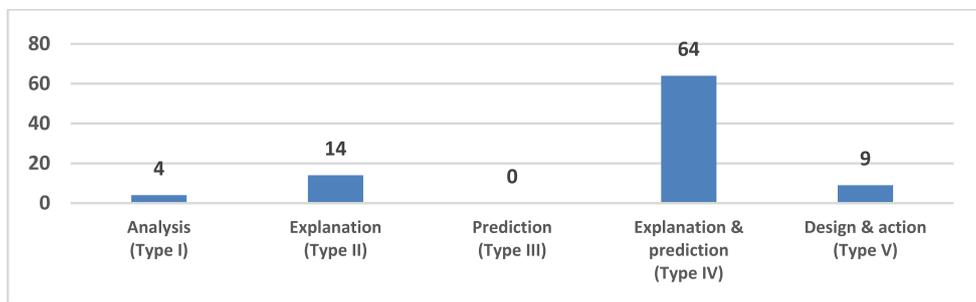


Fig. 4. A summary of Gregor's (2006) theory types used.

4.1. Data collection

We sought to find articles that used existing theories with management and organizational perspectives as foundations for understanding blockchain applications. The search string shown in Fig. 1 was applied to the title, abstract, and keywords of articles in Scopus and continued until April 2023. The search string returned 984 English documents from journal sources that are classified under the subject areas of business and management. By applying the following inclusion criteria, we aimed to

ensure the relevance of the articles included in our review. First, the title, abstract, and keywords of the 984 articles were screened. Accordingly, 84 articles were found that had evidence of using theory in their titles, abstracts, and keywords. Second, the texts of the remaining 900 articles were quickly screened to assess whether we can find traces of their use of theory. Consequently, besides 84 articles, we also found 22 others that seemed to be related to theories by including terms such as theoretical foundation, conceptual model development, hypothesis development, and deductive approach. Finally, the full texts of the 106

articles were thoroughly assessed, resulting in 91 articles whose findings were reported based on theories.

4.2. An overview of the theories used

As shown in Table 3, we found 46 theories used in 91 blockchain articles. According to Gassmann, Frankenberger, and Sauer (2016), who structured 50 theories into eight general categories for BM innovation research, we sorted out our 46 identified theories into seven categories for blockchain research. The 46 theories were sorted out according to their structural and functional similarities to understand blockchain-related applications and issues. The *adoption category* includes models, frameworks, and theories that evaluate the factors affecting the readiness, adoption, or diffusion of blockchain to decide whether to use blockchain or not. The *organizational economic category* examines the effects of blockchain on efforts to deal with information asymmetry and opportunism in economic system transactions. The *category of resource-based theories* shows how integrating blockchain, as an IT resource, in business processes increases the firms' competitive performance. The *category of social theories* evaluates the antecedents and outcomes of blockchain-enabled social interactions. The last two categories (i.e., resource-based and social theories) are also presented by Gassmann et al. (2016). The *sociomateriality category* concentrates on how the co-existence of blockchain technical actors and human/social actors changes business processes and managerial practices. The *category of trust-based theories* explores blockchain's potentials to build trust in business. Finally, some theories were included in the last category (i.e., *Other*), as they did not have functional similarities with each other and with other categories.

The distribution of 46 theories used in blockchain literature is summarized in Fig. 2. The diverse viewpoints of 46 theories show that blockchain can be used in many fields, topics and contexts of business and management. In other words, the wide scope and broad functioning of blockchain needs the views of different theories to understand blockchain applications. We found that out of 46 theories used, seven are related to IS discipline that fall into the adoption category, including diffusion of innovation (DOI), fit-viability model (FVM), organizing vision theory (OVT), technology acceptance model (TAM), technological-organizational-environmental framework (TOE), technology readiness index (TRI), and unified theory of acceptance and use of technology (UTAUT). The other 39 theories were borrowed from more established disciplines such as psychology, economics, sociology, and business.

Overall, adoption theories have been used the most with 45 times, especially technological-organizational-environmental framework (TOE) and technology acceptance model (TAM). The main reason is that the implementation of the immature and new blockchain technology requires significant initial financial investment, changes in existing operations or even innovating business models. Therefore, evaluating the benefits and challenges of blockchain adoption is one of the first concerns of this emerging research domain. The second-largest frequency (35 times) are theories with economic views. Actually, there is a significant conceptual overlap between the primary focuses of blockchain and the theories of this category, especially transaction cost economics (TCE) and agency theory (AT). In this sense, theories with economic views are focused on transactions and costs, and blockchain is a distributed ledger of transactions that promises to reduce their costs. In addition, theories with economic views deal with contract issues in economic relations, and blockchain provides the execution of the digital form of contracts known as smart contracts. However, according to Fig. 2, the effective study of the claimed capabilities of blockchain among various social and economic actors has also resulted in the use of other theoretical perspectives, including resource-based, social, sociomateriality, trust-based, etc.

Table 3
Theories used in blockchain literature.

Category	Theory	General conceptualization	Blockchain articles
Adoption	Behavioral reasoning theory (BRT)	BRT states that reasons serve as important linkages between people's beliefs, global motives (e.g., attitudes, subjective norms, and perceived control), intentions, and behavior (Westaby, 2005).	Oguntegbe, Di Paola, & Vona, 2022
	ARCS motivation model (ARCS model)	The ARCS model is a motivational design process that aimed to make instruction more appealing to learners. The model includes a synthesis of motivational concepts that are clustered into attention, relevance, confidence, and satisfaction (Keller, 1983).	Behl, Jayawardena, Pereira, & Sampat, 2022
	Diffusion of innovation (DOI)	DOI argued that relative advantage, complexity, compatibility, trialability, and observability are five characteristics of an innovation (Rogers, 2010).	Chen et al., 2021; Hartley, Sawaya, & Dobrzykowski, 2022; Karamchandani, Srivastava, & Srivastava, 2020; Liu, Ji, & Wei, 2022; Nath, Khayer, Majumder, & Barua, 2022; Toufaily, Zalan, & Dhaou, 2021
	Fit-viability model (FVM)	FVM consists of two core dimensions: (1) Fit: the extent to which technology features can fulfilled the requirement of task performance in an organization; (2) Viability: whether adopting a new technology needs essential support of financial resources, top management support, and IT infrastructure in an organization (Tjan, 2001).	Liang, Kohli, Huang, & Li, 2021
	Functional leadership theory (FLT)	FLT considers two categories of leadership behaviors include task-oriented leadership behaviors which provide guidance for processes and relation-oriented leadership	Mu, Bian, & Zhao, 2019

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Table 3 (continued)

Category	Theory	General conceptualization	Blockchain articles
		behaviors which promote member interaction (Yukl, 2012; Yukl, Gordon, & Taber, 2002).	
	Hofstede's cultural theory (HCT)	Hofstede's initial framework of national culture included the dimensions of individualism-collectivism, power distance, masculinity-femininity, uncertainty avoidance, and long-term/short-term orientation (Hofstede & Bond, 1988).	Salcedo & Gupta, 2021
	Institutional theory (INT)	INT argues that firms' actions are driven by their legitimacy motivations in seeking isomorphism to respond to three institutional pressures. Coercive pressures explain pressures from major customers, regulators, and industry associations that the firm is dependent on. Mimetic pressures occur when firms seek to replicate other firms' successful strategies. Normative pressures mean embracing the norms and rules of their institutional environments (DiMaggio & Powell, 1983).	Hartley et al., 2022; Tan, Gligor, & Ngah, 2022
	Organizing vision theory (OVT)	OVT defines how a shared vision from a community about an IT diffusion is formed. OVT notes that diffusion comprises three aspects: interpretation, legitimation, and mobilization (Swanson & Ramiller, 1997).	Perdana, Robb, Balachandran, & Rohde, 2021
	Sensemaking theory (SENS)	SENS refers to the ongoing interplay of action and interpretation, where actors develop particular assumptions, expectations and	Wang, Singgih, Wang, & Rit, 2019

Table 3 (continued)

Category	Theory	General conceptualization	Blockchain articles
		knowledge of the technology, which then shape their actions toward it (Weick, 1990).	
	Task-Technology Fit (TTF)	TTF focuses on the task characteristics, technology features, and how these two fit to enhance the performance of the target task (Goodhue & Thompson, 1995).	Choudhury et al., 2023
	Technology acceptance model (TAM)	TAM examines the technology adoption process through the perceptions of the end users on its usefulness and ease of use (Davis, 1989).	Bracci, Tallaki, Ievoli, & Diplotti, 2022; Chowdhury, Rodriguez-Espindola, Dey, & Budhwar, 2022; Das, 2020; Hashimy, Jain, & Grifell-Tatjé, 2022; Kamble, Gunasekaran, & Arha, 2019; Karamchandani et al., 2020; McNamara & Sepasgozar, 2020; Ullah et al., 2022; Yang, 2019
	Theory of planned behavior (TPB)	TPB suggests that behavior is determined by intentions, attitudes, subjective norms, and perceived behavioral controls (Ajzen, 1985).	Kamble et al., 2019
	Technological-organizational-environmental framework (TOE)	TOE determines the technological, organizational and environmental factors that have an impact on technology adoption of an organization (Tornatzky & Fleischer, 1990).	Caldarelli, Zardini, & Rossignoli, 2021; Chen et al., 2021; Clohessy & Acton, 2019; Gökalp, Gökalp, & Çoban, 2020; Guan, Ding, Zhang, & Verny, 2023; Hashimy et al., 2022; Nandi, Sarkis, Hervani, & Helms, 2021; Nath et al., 2022; Oguntege et al., 2022; Toufaily et al., 2021; Wong, Leong, Hew, Tan, & Ooi, 2020
	Technology readiness index (TRI)	TRI can be viewed as an overall state of mind resulting from a gestalt of mental enablers (optimism and innovativeness) and inhibitors (insecurity and discomfort) that collectively determine a person's predisposition to	Kamble et al., 2019; McNamara & Sepasgozar, 2020

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Table 3 (continued)

Category	Theory	General conceptualization	Blockchain articles
Organizational economic view	Unified theory of acceptance and use of technology (UTAUT)	use new technologies. UTAUT determines performance expectancy, effort expectancy, social influence, and facilitating conditions as exogenous constructs for predicting the behavioral intention and use (Venkatesh, Morris, Davis, & Davis, 2003).	Afifa, Van, & Van, 2022; Queiroz & Wamba, 2019; Queiroz, Fosso Wamba, De Bourmont, & Telles, 2021; Wong, Tan, Lee, Ooi, & Sohal, 2020
	Self-determination theory (SDT)	SDT focuses on the degree to which humans behavior is self-motivated and self-determined to satisfy their three basic psychological needs, namely autonomy, relatedness, and competence (Gagné & Deci, 2005).	Behl et al., 2022; Wang, Luo, & Lee, 2019
	Agency theory (AT)	AT is concerned with resolving two problems that can occur in agency relationships. The first problem arises when it is difficult for the principal to verify that the agent has behaved appropriately. The second problem arises when the principal and the agent may prefer different actions because of the different risk preferences (Eisenhardt, 1989).	Beck, Müller-Bloch, & King, 2018; Chaudhuri, Bhatia, Kayikci, Fernandes, & Fosso-Wamba, 2021; Han, Shiwakoti, Jarvis, Mordi, & Botchie, 2023; Liu, Zhang, He, & Li, 2021; Meier & Sannajust, 2021; Murray, Kuban, Josefy, & Anderson, 2021; Sun, Garimella, Han, Chang, & Shaw, 2020; Tan et al., 2022
	Cooperative theory (CT)	CT focuses on business structure of a cooperative and related principles such as mutual value creation, fair distribution of power, democracy, liberty and responsibility (Watkins, 1986).	Kollmann, Hensellek, de Cruppe, & Sirges, 2020
	Mechanism design theory (MDT)	MDT focuses on the concept of incentive compatibility among parties in an economic system. If every party is motivated to be honest when sharing their information and obedient to the designed plan, that plan can be	Nguyen & Nguyen, 2022

Table 3 (continued)

Category	Theory	General conceptualization	Blockchain articles
	Multiple-channel communication Theory (MCCT)	considered incentive compatible (Hurwicz, 1973). MCCT explains that different communication channels influence the signal effects on reducing information asymmetry. The multiple information channels have their distinct characteristics on information schema, source credibility and communication direction (Moore, Burton, & Myers, 2004).	Chen, 2019
	Property rights theory (PRT)	PRT proposes that ownership and control rights over the assets should be given to the parties that make ex-ante specific investments (Hart, 1995).	Meier & Sannajust, 2021; Schneider, Leyer, & Tate, 2020
	Signaling theory (SIG)	SIG explains how information asymmetry between parties is reduced by sending signals to convey the missing information. Signals are observable actions sent by the informed party to the less informed party to disclose necessary information to facilitate the transactions and encourage future ones (Spence, 2002).	Campino, Brochado, & Rosa, 2022; Fisch, 2019; Hackober & Bock, 2021; Nguyen & Nguyen, 2022; Piñeiro-Chousa, López-Cabarcos, & Ribeiro-Soriano, 2021; Treiblmaier & Garaus, 2023; Xu, Dai, Paulraj, & Chong, 2022; Ying, Peng, Zhao, & Chen, 2023
	Transaction cost economics (TCE)	TCE prescribes the optimal governance structure (market vs. hierarchy) to minimize total cost under the environmental uncertainties, behavioral uncertainties and asset specificity on the transaction (Williamson, 1981). The transaction costs need to search and process information, bargain and (re-) negotiate contracts, and enforce	Ahluwalia, Mahto, & Guerrero, 2020; Chen, Botchie, Braganza, & Han, 2022; Dal Mas, Dicuonzo, Massaro, & Dell'Atti, 2020; Denter, Seeger, & Moehrle, 2023; Hasan, Shiming, Islam, & Hossain, 2020; Jabbar & Dani, 2020; Long, Feng, Fan, & Liu, 2022; Meier & Sannajust, 2021; Murray et al., 2021; Pereira, Tavalaei, & Ozalp, 2019; Roeck,

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Table 3 (continued)

Category	Theory	General conceptualization	Blockchain articles
Resource-based theories	Dynamic capabilities (DC)	agreements (Miles, 2012).	Sternberg, & Hofmann, 2020; Schmidt & Wagner, 2019; Sun et al., 2020; Zhang, Wei, Jiang, Peng, & Zhao, 2021
		DC is the capacity of an organization to create, extend, and modify its resource and processes to sustain long-term competitive advantage under rapidly changing business environment (Teece, Pisano, & Shuen, 1997).	Dwivedi, Balakrishnan, Das, & Dutot, 2023; Kamble et al., 2021; Kusi-Sarpong, Mubarik, Khan, Brown, & Mubarak, 2022; Lambourdiere & Corbin, 2020; Martinez et al., 2019; Sheel & Nath, 2019
	Organizational information processing theory (OIPT)	OIPT suggests that organizations' structure and processes revolve around information flows to reduce task uncertainty through information processing (Galbraith, 1974).	Cerchione, Centobelli, Riccio, Abbate, & Oropallo, 2023; Dubey, Gunasekaran, Bryde, Dwivedi, & Papadopoulos, 2020; Martinez et al., 2019; Sangal, Nigam, & Bhutani, 2022
	Practice-based view theory (PBT)	According to PBT, practice refers to a certain activity or a set of processes that various organizations can use, which is imitable and publicly known (Bromiley & Rau, 2014).	Rehman Khan et al., 2022
Resource-based view of the firm (RBV)	Resource dependence theory (RDT)	RBV states that in order to achieve a competitive advantage, organizations need to develop resources that are valuable, rare, imperfectly imitable, and non-substitutable supported by tacit skills and socially complex organizational processes (Barney, 1991).	Hackober & Bock, 2021; Karamchandani, Srivastava, Kumar, & Srivastava, 2021; Martinez et al., 2019; Nandi, Nandi, Moya, & Kaynak, 2020; Nandi et al., 2021; Nigam et al., 2022; Sharma, Alkatheeri, Jabeen, & Sehwat, 2022
		RDT explains that how organizations are influenced by external resources in an alliance; And, how actions or processes related to the use of external resources lead to the organization's competitive advantage (Pfeffer & Salancik, 2015).	Guan et al., 2023; Long et al., 2022; Nandi et al., 2021

Table 3 (continued)

Category	Theory	General conceptualization	Blockchain articles
Social theories	Relational view of competitive advantage (RV)	RV identifies four potential sources of inter-firm competitive advantage: relation-specific assets, knowledge sharing routines, complementary resources/ capabilities, and effective governance (Dyer & Singh, 1998).	Dubey et al., 2020; Xu et al., 2022
	Intellectual capital based view (ICV)	ICV asserts that the combination of an organization's relationships with its suppliers, customers, and employees (relational capital), the organization's processes and routines (structural capital), and knowledge rooted in an organization's human resources (human capital) create a unique resource, which can significantly influence organizational performance (Secundo, Perez, Martinaitis, & Leitner, 2017).	Kusi-Sarpong et al., 2022
	Service-dominant logic (S-D logic)	S-D logic explains the value-creation processes with service offerings and reciprocal application of resources for others' benefit. Service value is created in interactions and depends on the quality of the relationship (Vargo & Lusch, 2004).	Wang, Luo, Lee, & Benitez, 2022
Social theories	Social capital theory (SCT)	SCT refers to the productive resources emerging from a firm's social network of its members, which affect the subsequent organizational performance. Social capital includes structural capital, relational capital and cognitive capital (Nahapiet & Ghoshal, 1998).	Galati, 2022; Liu, Li, Min, & Chang, 2022
	Social exchange theory (SET)	SET explains how stimuli, punishments, and rewards impact	Sadeghi, Prybutok, & Sauser, 2022; Wang et al., 2022

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Table 3 (continued)

Category	Theory	General conceptualization	Blockchain articles
Sociomateriality	Social identity theory (SIT)	members' behaviors to exchange resources (Homans, 1974). SIT explains how individuals self-categorize into different social groups and thereby create distinct social identities that serve as schemes of social orientation.	Schüctkes & Gutmann, 2021
	Social network theory (SNT)	SNT evaluates a specific set of linkages among a defined set of actors, with the additional property that the characteristics of these linkages as a whole may be used to interpret the social behavior of the actors involved (Mitchell, 1969).	Bai, Zhu, & Sarkis, 2021; Queiroz & Wamba, 2019
	Social proof theory (SPT)	According to SPT, people rely on the collaboratively shared information and experiences of others to infer a course of action, especially when they face uncertainty in decision-making (Cialdini, Wosinska, Barrett, Butner, & Gornik-Durose, 1999).	Dal Mas et al., 2020
	Affordance-actualization (AA-lens)	AA-lens explains the IT-associated organizational change processes by acknowledging the distinct roles played by IT and the actors involved in the changes. The processes distinguish between affordances and actualization (Strong et al., 2014).	Du, Pan, Leidner, & Ying, 2019; Szabó, Ternai, & Fodor, 2022
Sociomateriality	Actor-network theory (ANT)	ANT explores how networks are built or assembled by the human and non-human actors to reach a certain objective (Latour, 1996).	Islam, Mäntymäki, & Turunen, 2019; Schneider et al., 2020
	Fit-appropriation model (FAM)	FAM proposes that team performance is influenced by the fit between task characteristics and technology features, mediated by way the users appropriate/use	Choudhury et al., 2023

Table 3 (continued)

Category	Theory	General conceptualization	Blockchain articles
Trust-based theories	Theory of swift trust (TST)	the social structures those technology features enable (Dennis, Wixom, & Vandenberg, 2001). TST explains the presumptive form of trust between parties who interact for temporary goal-oriented groups. The success depends on how well the activities is coordinated between the parties (Meyerson, Weick, & Kramer, 1996).	Sangal et al., 2022
	Trust-based marketing theory (TBMT)	TBMT focuses on customer advocacy techniques that assist consumers in making informed purchase decisions based on marketplace options and equitable advice. It states that being honest and open is the best path to building consumer trust and loyalty (Urban, 2003).	Nigam et al., 2022
	Trust transfer theory (TTT)	TTT explains how an individual's trust in an entity can be transferred to another related target entity. The nomological network among trust targets shows their specific relationships. When users positively assess the relationship, they tend to build trust beliefs and transfer from one trust target to another (Stewart, 2003).	Shao, Zhang, Brown, & Zhao, 2022
Other	Psychological ownership theory (POT)	POT explains a psychological state where individuals feel as though the target of ownership is 'theirs'. Enterprises expect to improve their performance through providing employees with an ownership interest in company as incentive mechanisms (Pierce, O'driscoll, & Coghlan, 2004).	Liu, Li, et al., 2022

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Table 3 (continued)

Category	Theory	General conceptualization	Blockchain articles
	Stakeholder theory (ST)	ST focuses on the analysis of the wide range of parties involved in economic value-creation processes, including customers, employees, investors, and suppliers (Freeman, 2010).	Denter et al., 2023; Han et al., 2023
	Systems theory (Syst)/ system of systems (SoS) theory	Syst understands the individual and his environment as part of a broad interactive system to study the interactions from different holistic perspectives (Skyttner, 2005). A system provides unique capabilities that none of the constituent systems can accomplish on its own.	Campino et al., 2022; Hong & Hales, 2021; Mangla et al., 2021; Zeltst, Green, Sower, & Bond, 2020
	Value disciplines model (VDM)	VDM focused on delivering superior customer value in line with at least one of three value disciplines – operational excellence, customer intimacy, or product leadership (Treacy & Wiersema, 1993).	Bauer, Zavolokina, Leisibach, & Schwabe, 2020; Rajnak & Puschmann, 2021

4.3. Blockchain application areas and issues studied by theories

We read 91 selected articles and used an inductive-deductive thematic analysis to identify issues and areas related to blockchain applications that have been studied by theories. The main- and sub-themes are respectively areas and issues related to blockchain applications. Issues (26 sub-themes) are the benefits and challenges associated with blockchain applications that were inductively explored in the literature. Next, we adopted Maghazei, Lewis and Netland's (2022) framework to deductively classify the 26 induced issues into five areas (i.e., five main-themes). Maghazei et al. (2022) presented a technology adoption framework that examines the fit between the emerging technology and (1) economic and strategic factors (pre-adoption), (2) operational and supply chain factors (early adoption), and (3) organizational and behavioral factors (adoption). Accordingly, we generally considered five application areas of emerging blockchain technology including economic, strategic, operational, behavioral, and implementation consideration (i.e., organizational) areas. Main- and sub-themes were refined and agreed upon between two authors to best represent the body of literature on blockchain applications. The 5 identified areas and 26 explored issues of blockchain applications are presented in Table A.1 of the Appendix.

Fig. 3 shows a summary of areas and issues related to blockchain applications. The largest proportion (31%) of articles focused on behavioral area of blockchain applications. Accordingly, blockchain forces trading partners to be proactive in accountability and adopting appropriate behaviors. This area indicates that blockchain provides four

general benefits to overcome unsustainable business practices, including performance monitoring, reduction in lock-in effects, task programming and token incentivization scenarios, and finally inter-firm trust and commitment. The latter (i.e., trust and commitment) is the most frequent—10% overall and 31% within behavioral area. The second-largest percentage (22%) is the improvement of firms' operational capabilities. Among them, blockchain has the highest impact on transparency, traceability and visibility of operations, 10% overall and 46% within operational area. The blockchain implementation considerations represent the third-largest proportion (19%) of articles. As the blockchain is a newly research domain, exploring the internal and external motivations and pressures related to choosing blockchain is indeed important issue to address. For example, the existence of a supportive environment (e.g., regulatory support, standardization, and culture of intrapreneurship) is one of the necessary antecedent factors for the successful blockchain implementation. The fourth-largest percentage (16%) is economic application area, which shows that blockchain positively or negatively affects the cost structure of firms, including the costs of search, monitoring, bargaining, contract inflexibility, control of oracles, and verification and storage. Finally, the lowest proportion (13%) of articles concentrated on the strategic applications to examine the impacts of blockchain on strategic competencies and relational rents. For example, researchers showed that blockchain facilitates collaboration among firms in different industries to enable product and service innovation at the ecosystem level. In general, since the blockchain is fundamentally a network-based technology, achieving and reporting its strategic outcomes require the active participation of all business stakeholders, which may take a long time.

4.4. An overview of Gregor's (2006) theory types used

We presented the conceptual model of the research based on Gregor's (2006) taxonomy to specify the types (forms) of theory used in the literature. As shown in Section 3, Gregor (2006) distinguished five types of theory for IS studies. We coded theories from our literature as Type I that simply analyzed what the benefits, challenges, and applications of blockchain are in business and management. Type II represents theories that provide explanations and causal reasoning about blockchain applications, but do not provide testable propositions (hypothesis). As Type III, theories provide predictions and testable propositions (hypothesis) about blockchain applications, but lack justifying causal explanations. Type IV represents theories that provide both causal explanations and testable propositions (hypothesis) about blockchain applications. Finally, as Type V, we coded theories that prescribe explicit procedures for developing, designing, or evaluating blockchain-based systems.

Fig. 4 summarizes Gregor's (2006) theory types used in the literature. We found that theories were mostly (64 times) used for explaining and predicting (Type IV). Few studies contributed to theories for explaining (Type II), design and action (Type V) and especially analyzing (Type I). No articles used predictive type theory (Type III). According to Gregor (2006), as clear definition of constructs is needed in all types of theory, analytic theory (Type I) is necessary for the development of other types. Therefore, all 46 identified theories have an analysis purpose to identify the key constructs of blockchain phenomena. However, most articles used theories for purposes beyond mere analysis—in particular, for explanation and prediction (Type IV). In addition, theories often provide causal justification for predicting why outcomes occur. This is why there are more Type 4 theories than Type 2, which explains but do not aim to predict. Also, since there were not theories that achieve predictions without necessarily having explaining of the causal reasons, none of them fall into Type III. This finding is consistent with Gregor's (2006) statement that Type III theory is more prevalent in natural sciences than social sciences. Finally, theories rarely (9 times) prescribed procedures for designing, evaluating, or implementing blockchain applications (Type V). One of the main reasons is that using Type V of theory is more

prevalent in subject areas like computer sciences, engineering, and mathematics, which are not our research area (See Section 2).

5. Reviewing Gregor's (2006) theory types for investigating the blockchain applications

This section analyzes Gregor's (2006) types of 46 identified theories investigating five economic, strategic, operational, behavioral, and implementing consideration areas of blockchain applications. We structure the section along five sub-sections following analysis results of each of the five blockchain application areas. The five blockchain application areas and related issues are introduced in Section 4.3. Some theories may be used to examine more than one area and issue related to blockchain applications. Within all sub-sections, results are reported per each theoretical category identified in Section 4.2. Since our research is context-independent, the blockchain application issues are narrated without addressing country, industry, community, or organizational factors (e.g., organization size) under investigation. Tables 4 to 8 present the research questions posed in the five blockchain application areas. However, to show what exactly the research questions mean, we preferably specified them according to research contexts. In the last paragraph of the subsections, we propose potential research questions from the theory to further understand the blockchain applications. In this regard, we searched for reviewed issues related to blockchain applications that have been under-researched or overlooked by some theory types of Gregor's (2006) taxonomy. Since our review is general-domain, questions are not limited to specific blockchain topics and areas. Therefore, researchers can use these questions to develop middle-range theories in a specific blockchain research domain. Of the 46 theories identified in Section 4.2, we suggested the most applicable theories to address the questions. Table A.2 in the Appendix presents the coding of each blockchain article in terms of Gregor's (2006) theory types used to investigate five areas of blockchain applications.

5.1. Theory types for investigating the blockchain economical applications

In Table 4, a range of theories is presented in different categories used in the literature to study the impacts of blockchain on the cost structure of businesses. In the following, seven economic issues of blockchain applications are highlighted in italics.

In the adoption category of Table 4, researchers using DOI, SENS, TAM, TOE, and TRI studied what factors affect blockchain adoption (Type I) and how the factors will affect (Type IV). They found that a *reduction in search and information cost* is a measurement index for the perceived usefulness of blockchain. Also, the usefulness of smart contracts in automating the evaluation and forecasting partners' performance has an impact on *reducing monitoring costs* and a greater willingness to adopt blockchain. In addition, the ease of use of smart contracts' negotiation processes affects *reducing bargaining costs* and higher adoption of blockchain. In contrast, high hardware costs for *transaction verification and storage* adversely affect the ease of use of blockchain. *High control costs of oracles* are another challenge for the successful operation of a smart contract and the willingness to adopt blockchain. In addition, the difficulty of setting and interpreting legal rules in smart contracts, incurring *high inflexibility costs of smart contracts*, reduces the willingness to adopt blockchain to improve collective value creation. Hence, in order for the adoption of smart contracts to create collective value, external governance mechanisms such as human interventions are needed to evaluate the performance of contracts and resolve unforeseen disputes. SDT was employed to discuss why users are motivated to adopt a blockchain application, how they perceive the values created, and whether they will use it again. In this respect, researchers explained and predicted that a *reduction in search and monitoring costs* for the P2P exchange of multiple digital assets could provide the economic motivation and value needed for customers to join blockchain (Type IV).

In the organizational economic category of Table 4, researchers using AT and TCE explained or predicted that blockchain could transform transaction and agency costs and lead to the emergence of new technological costs (types II and IV). They found that blockchain *reduces search and information costs* by reducing information asymmetry in the business network. In addition, access to the firm's transaction records and automatic implementation of contractual obligations *reduce monitoring costs of partners' performance*. Concerning the impacts of blockchain on bargaining costs, two distinct results were reported, depending on the extent of environmental uncertainty of transactions. Some results showed that the *bargaining costs of smart contracts decrease under low environmental uncertainties* because decision-makers can predict scenarios that are more possible for the terms of the contract based on the data stored in the blockchain. Therefore, there is little need for renegotiation and adaptation of agreements. On the contrary, some results showed that *bargaining costs rise under high environmental uncertainties*. In fact, in high environmental uncertainties, more negotiations need to be carried out to accurately predict the requirements and define the relationships among partners, as a slight error in the terms of smart contracts can disrupt trust in the entire network. Studies also pointed to the emergence of three new technological costs on the blockchain platform. The first technological cost is related to the *inflexibility of smart contracts* in the absence of human interventions and artificial intelligence as adaptive methods to specific events. Such inefficiency results from the impossibility of accurately defining and interpreting all terms of smart contracts, which increases the necessity of evaluating the performance of contracts by third parties. Also, executing contract decisions based on the results of artificial intelligence reduces the impact of environmental uncertainties and increases the efficiency of smart contracts. The second technological cost is related to oracle problems (*Control costs of oracles*). Oracles, as a third party, provides real-world data to draft and execute smart contracts to exchange physical assets. However, the requirements of finding suitable oracles and evaluating their performance increase search and information costs in transactions. In addition, the dependence of smart contracts on oracle's data sources requires monitoring costs to reduce the risks of lock-in effects. The third technological cost is related to transaction *verification and storage*. *Verification costs* refer to the efforts (such as time, energy, and computing power) required to process transactions, add new data, update the ledger, and maintain blockchain integrity. High computing power and energy consumption lead to environmental concerns that increase the need to design sustainable consensus mechanisms. *Costs of storage* and infrastructure, that is, hardware devices needed to store real-world online data, are among other technological costs of blockchain (types II and IV). In addition, TCE was used to provide prescriptions for the design of a blockchain-based technical model to further reduce auditing and *monitoring costs*. This model was prescribed to solve the two challenges of current blockchains in authenticating and representing recorded transaction interdependence in a particular business network (Type V). Using PRT, the researchers explained that interactions become more efficient as blockchain-enabled transparency and traceability create *lower costs of monitoring* property rights (Type II).

In the resource-based category of Table 4, the impact of blockchain's benefits - as a specific IT resource - on the dimensions of the value chain and the performance of firms was enquired. RBV and PBT were used to explain and predict that the *reduction in search costs* and the *reduction in monitoring costs* that are blockchain-specific capabilities, positively affect business practices (Type IV).

Finally, in the sociomateriality category of Table 4, researchers using ANT explained how blockchain technical actors and social actors play a role in the novelty, efficiency, and lock-in effects of blockchain networks. They explained that the ledger-enabled transparency and traceability reduce the *search costs* and the *monitoring costs* of transactions (Type II).

According to the research gaps seen in Table 4, additional studies along with the suggested theories can be performed to investigate *what*

Table 4
Gregor's (2006) theory types for investigating the blockchain economical applications.

Category	Theory	Article	Gregor's (2006) theory taxonomy		Blockchain economical applications								
			Type	Research questions under investigation	Lower search & information costs	Lower monitoring costs	Lower bargaining costs	More bargaining costs	Inflexibility of smart contracts	Control costs of oracles	Verification & storage costs		
Adoption	DOI	Toufaily et al., 2021	I	What are the factors affecting the adoption of blockchain in private and public sectors?		×				×		×	
		Karamchandani et al., 2020	IV	What are the factors affecting the adoption of blockchain in supply chains? How will the factors affect?	×								
	SDT	Wang, Luo, & Lee, 2019	IV	Why are users extrinsically motivated to join a blockchain platform? How will they perceive the created values? Whether they would join again?	×	×							
	SENS	Wang, Singgih, et al., 2019	I	What are blockchain's perceived benefits or challenges for the supply chains?		×					×		
	TAM	Bracci et al., 2022; Das, 2020; Karamchandani et al., 2020; McNamara & Sepasgozar, 2020	IV	What are the factors affecting the adoption of blockchain in SMEs? In supply chains? How will the factors affect? How will the smart contracts inhibit opportunistic actions and effectively govern cooperation and value co-creation?	×	×	×		×	×		×	
	TOE	Toufaily et al., 2021	I	What are the factors affecting the adoption of blockchain in private and public sectors?		×				×			×
		Guan et al., 2023; Wong, Leong, et al., 2020	IV	What are the factors affecting the adoption of blockchain in supply chains? How will the factors affect?									×
TRI	McNamara & Sepasgozar, 2020	IV	What are the factors ascertaining the readiness of the firms for smart contract adoption? How will the factors affect? How will a smart contract prevent opportunistic business actions?		×	×		×		×			
Organizational economic view	AT	Beck et al., 2018	II	How does blockchain transform the agency costs of a firm and introduce new technological costs?				×	×			×	
		Sun et al., 2020	IV	How does blockchain transform the agency costs of a firm and introduce new technological costs in insurance?	×	×		×			×		
	Meier & Sannajust, 2021; Murray et al., 2021	II	How does blockchain introduce new technological costs?					×		×	×		
	PRT	Schneider et al., 2020	II	How can blockchain help exchange and monitor property rights in a business ecosystem?		×							
	TCE	Dal Mas et al., 2020; Chen et al., 2022; Meier & Sannajust, 2021; Murray et al., 2021	II	How does blockchain transform the transaction costs of a firm and introduce new technological costs, especially in global value chains?	×	×		×	×	×	×	×	×
Ahluwalia et al., 2020; Hasan et al., 2020; Pereira et al., 2019; Roeck et al., 2020; Schmidt & Wagner, 2019; Sun et al., 2020		IV	How will blockchain transform the transaction costs of a firm and introduce new technological costs, e.g. in startup financing, supply chains, or insurance?	×	×	×	×	×	×	×	×	×	

(continued on next page)

Table 4 (continued)

Category	Theory	Article	Gregor's (2006) theory taxonomy		Blockchain economical applications							
			Type	Research questions under investigation	Lower search & information costs	Lower monitoring costs	Lower bargaining costs	More bargaining costs	Inflexibility of smart contracts	Control costs of oracles	Verification & storage costs	
Resource-based theories		Jabbar & Dani, 2020; Zhang et al., 2021	V	How to further reduce transaction audit costs on blockchain-based platforms, e.g. in care insurance? <i>Which will be the dimensions of the cost structure of the value chain that blockchain is perceived to improve for?</i>		×						×
	RBV	Karamchandani et al., 2021	IV		×							
	PBT	Rehman Khan et al., 2022	IV	How will blockchain-enabled circular economy practices improve sustainable practices and organizational performance? <i>Why do blockchains split? Who are the heterogeneous actors involved? How do they enable efficiency gains to transform BMs and ecosystems?</i>			×					
Sociomateriality	ANT	Schneider et al., 2020	II		×							

are the effects of blockchain-induced technological costs on blockchain adoption? (Type I)—using AT, SENS, TCE, and TRI. *How* are disputed transactions related to the inflexibilities of smart contracts resolved in the absence of third-party intervention? (Type II)—using AT, SoS, and Syst. *How will* the blockchain lead to transactional efficiencies and shifts in competitive power? (Type IV)—using PBT, RBV, RDT, RV, and TCE. *How will* blockchain reduce the transaction costs for horizontal and vertical stakeholders? (Type IV)—using CT, SoS, Syst, and TCE. *How* to address the bargaining costs currently faced by blockchain platforms? *How to* design blockchain solutions that minimize lock-in to the oracles' data sources? *How to* design smart contracts that are more flexible against contingencies? (Type V)—using AA-lens, ANT, AT, SoS, Syst, and TCE.

5.2. Theory types for investigating the blockchain strategic applications

In the following, according to Table 5, a range of theories in different categories used to study the strategic issues of blockchain applications is presented. Four blockchain application issues are highlighted in italics.

In the adoption category of Table 5, based on ARCS, DOI, SENS, TAM, and TOE, researchers evaluated *what* factors affect the adoption of blockchain applications (Type I) and *how* they will affect (Type IV). The researchers found that blockchain-enabled *integration* with customers and suppliers was identified as a key determinant of blockchain adoption. In addition, improving *customer intimacy* through relationship management and better service levels to them, as well as creating *decentralized relational structure*, were considered as benefits of adopting blockchain. Also, adopting blockchain to build trust, integrate resources, make tasks transparent, and replace traditional vertical value chains can enhance *the collaboration and innovation capabilities of the firms*. SDT was used to explain and predict that blockchain could intrinsically increase *customer intimacy* by improving customers' motivations and perceived values (Type IV). First, the blockchain features, including secure, controllable, and near real-time peer-to-peer (P2P) exchanges of multiple assets, can fulfill the psychological motivations of customers' autonomy and competence. Second, the *decentralized relational structure* of blockchain can improve relatedness motivation and social interaction values of customers.

In the organizational economic category of Table 5, AT was used to examine how blockchain could change the governance in inter-firm relationships. The researchers explained that *the alignment of actors* in the blockchain network could be the basis for decentralized disagreement resolution (Type II). In turn, the decentralized governance of disagreements may lead to the fork (or split) of a blockchain network into separate organizations of actors with common strategic goals. Accordingly, blockchain creates a *decentralized relational structure* among the actors. In addition, AT was used to prescribe how to innovate a traditional BM by integrating blockchain to reduce information asymmetry in an agency. The researchers prescribed that by improving the business network component in traditional BMs, blockchain can create an *efficient collaboration* and *decentralized relational structure* at the ecosystem level that does not suffer from hidden information and actions (Type V). TCE was applied to explain and predict the effects of blockchain on transaction costs, governance structure, and boundaries of an organization. In this regard, researchers often explained and predicted that if blockchain reduces transaction costs, the *decentralized relational structure* and ad-hoc markets will replace vertical integration (Type IV). Also, TCE was used to explain and predict how will blockchain can guarantee *business integration* with customers and suppliers by building trust and reducing transaction costs (Type IV). Additionally, CT was borrowed to explain blockchain as an enabler of cooperative electronic marketplaces with *decentralized relational structures* (Type II).

In the resource-based category of Table 5, researchers examined the effects of blockchain on *integration* and *collaboration of the firms* to achieve high performance. Using DC and RDT, researchers explained and predicted that blockchain improves *internal integration* and *external*

Table 5
Gregor's (2006) theory types for investigating the blockchain strategic applications.

Category	Theory	Article	Gregor's (2006) theory taxonomy		Blockchain strategic applications			
			Type	Research questions under investigation	Integration & alignment	Collaboration & innovativeness	Customer intimacy	Decentralized relational structure
Adoption	ARCS	Behl et al., 2022	IV	How will the drivers of blockchain use improve supply chain performance?	×			
	DOI	Chen et al., 2021; Toufaily et al., 2021	I	What are the factors affecting the adoption of blockchain in supply chains? In private and public sectors?	×	×	×	×
		Liu, Ji, & Wei, 2022	IV	How will blockchain adoption promote collaborative product innovation in the supply chains?		×		
	SDT	Wang, Luo, & Lee, 2019	IV	Why are users intrinsically motivated to join a blockchain platform? How will they perceive the created values?			×	×
	SENS	Wang, Singgih, et al., 2019	I	What are blockchain's perceived benefits for the supply chains? Where are disruptions mostly likely to occur?				×
	TAM	Chowdhury et al., 2022; Das, 2020; Hashimy et al., 2022	IV	What are the factors affecting the adoption of blockchain in supply chains? In Spanish firms? How will the factors affect? How will smart contract adoption transform the inter-firm cooperation and value co-creation?	×	×	×	×
		TOE	Chen et al., 2021; Toufaily et al., 2021	I	What are the factors affecting the adoption of blockchain in supply chains? In private and public sectors?	×	×	×
Organizational economic view	AT	Beck et al., 2018	II	How can blockchain change the governance dimensions?	×			×
		Liu et al., 2021	V	How to innovate a traditional supply chain finance BMs by integrating blockchain to reduce information asymmetry?		×		×
	CT	Kollmann et al., 2020	II	How can using the blockchain realize cooperative principles on electronic marketplaces?				×
	TCE	Long et al., 2022; Pereira et al., 2019; Schmidt & Wagner, 2019; Sun et al., 2020	IV	How will blockchain-enabled decentralized governance structure affect the transaction costs of supply chain relationships? How will blockchain reduce the boundaries of an organization? How will blockchain build trust to enhance supplier and customer integrations?	×			×
Resource-based theories	DC	Kamble et al., 2021; Sheel & Nath, 2019	IV	How will blockchain improve supply chain integration and performance?	×			
	RBV	Nandi et al., 2020	IV	How will blockchain improve supply chain integration, collaboration, and performance?	×	×		
	RV	Dubey et al., 2020	IV	How will blockchain enhance collaboration and resilience within a humanitarian supply chain?		×		
	RDT	Guan et al., 2023; Long et al., 2022	IV	How will blockchain improve supply chain integration to manage resource dependency?	×			
	S-D logic	Wang et al., 2022	II	Why and how can blockchain improve service offering in the supply chain finance?	×	×		
Social theories	SCT	Galati, 2022	IV	How will social capital affect the adoption of blockchain solutions in supply networks?	×			
	SPT	Dal Mas et al., 2020	II	How can smart contracts reduce the transaction costs of a firm to develop sustainable BMs?				×
Sociomateriality	ANT	Islam et al., 2019; Schneider et al., 2020	II	Why do blockchains split? Who are the heterogeneous actors involved? How do they enable a range of novelties, efficiency gains, and lock-in effects to transform BMs and ecosystems?	×	×		×

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Table 5 (continued)

Category	Theory	Article	Gregor's (2006) theory taxonomy		Blockchain strategic applications			
			Type	Research questions under investigation	Integration & alignment	Collaboration & innovativeness	Customer intimacy	Decentralized relational structure
	FAM	Choudhury et al., 2023	IV	How will firms appropriate the social structures to enable blockchain features in truck freight marketplace and achieve higher performance?	×			×
Other	VDM	Rajnak & Puschmann, 2021	IV	How will blockchain affect the BM in banking? How banking will be able to maximize business value from blockchain?		×	×	
		Bauer et al., 2020	V	How to create value from a decentralized car ledger? How to enable early value creation for all stakeholders to reap individual benefits later?		×	×	
	ST	Han et al., 2023; Denter et al., 2023	IV	How will blockchain improve stakeholder collaborations in patent management tasks? How will blockchain change the accounting and auditing practice of stakeholders?	×			×

integration in a business network (Type IV). In the former, blockchain can integrate all functional departments in the internal business processes by building trust and highly interoperable ISs. In this respect, all internal departments of a business are aligned toward a common goal with collective access to process data sources. In the latter, blockchain can align the members of a business with their suppliers and key customers by creating a trusted ecosystem. Likewise, suppliers and customers can participate in solving problems and designing products for a business. RBV was used to explain and predict how blockchain as a specific IT resource will create a reliable ecosystem to boost integration and collaborations of the firms to innovate business products (Type IV). RV was used to explain and predict blockchain as an enabler of two main cornerstones in active collaborations of the firms - efficient sharing of information and building trust (Type IV). Using S-D logic, researchers explained blockchain as an enabler of collaborations and process integrations so that resource exchange is facilitated in offering services and all stakeholders benefit from value creation (Type II).

According to Table 5, in the category of social theories, the cognitive capital dimension of SCT was used to explain and predict that if blockchain is viewed as an opportunity for strategic goal alignment in a business network, the willingness to adopt blockchain will increase (Type IV). Also, SPT was used to explain how smart contracts can form market and customer-centric relationships, i.e., a decentralized relational structure, by developing a new social proof (Type II).

In the sociomateriality category of Table 5, researchers using ANT explained why blockchain-based networks evolve and what the role of the involved actors is. The researchers explained that the development of a blockchain network and its splits result from alignment and collaboration among blockchain technical actors and a sufficient number of social actors. Alignment and collaborations of involved actors are formed as a decentralized relational structure leading to new activities, partnerships, and governance mechanisms (Type II). FAM was borrowed to explain and predict how firms appropriate blockchain-enabled decentralized relational structure to achieve higher goal alignment (Type IV).

In the last category of Table 5, i.e., other, VDM was used to explain and predict how will blockchain affect the BMs and value creation process of firms (Type IV). In this respect, studies showed that common information infrastructure of blockchain can realize the value discipline of product leadership by improving collaborations and innovations at the ecosystem level. Moreover, commercialization and customization of the data stored in blockchain help realize the customer intimacy of value discipline. Of course, one of the studies has prescribed guidelines to direct design decisions: how to achieve multiple value disciplines and

how to create initial value for all stakeholders while benefitting from individual advantages (Type V). In addition, ST was used to explain and predict that by developing an open and inclusive ecosystem and, at the same time, reorganizing or discarding stakeholders, blockchain can establish decentralized relational structures in which there is no informational advantage or innovation barriers for stakeholders. Also, blockchain facilitates the collaboration capability of a diverse range of stakeholders in viewing, updating and validating transactions (Type IV).

According to Table 5, existing research efforts on blockchain-enabled customer intimacy have been neglected (Type II) or under-researched (Types I and V). Future research can contribute to seek further answers to the following questions. Some promising theories are proposed that can be used to answer these questions. How can blockchain improve customer-focused performance of firms? How can blockchain characteristics interplay with customer cognition and purchase intention? How can blockchain fundamentally alter the nature and quality of customer integration? (Type II)—using ANT, OIPT, OVT, PBT, RBV, SDT, SPT, TBMT, TTT, and VDM. How to push the structure of an organization from hierarchies toward electronic customer-focused markets on blockchain? (Type V)—using CT, HCT, ICV, and TCE. The following questions pertaining to blockchain-enabled decentralized relational structure can be investigated. When will collusion happen in a blockchain-enabled business system and how to avoid such possibilities through blockchain splitting? (Type V)—using ANT, FLT, POT, SoS, and Syst.

5.3. Theory types for investigating the blockchain operational applications

In the following, according to Table 6, we describe a range of theories in different categories used in the literature to study the operational issues of blockchain applications. Five blockchain application issues are highlighted in italics.

In the adoption category, most studies using ARCS, DOI, FVT, SENS, TAM, TOE, TRI, TTF and UTAUT have explained and predicted how the blockchain's potentials to improve the operational capabilities of firms affects technology adoption and how blockchain features can bridge the business process fulfillment gaps (Type IV). Other studies analyzed and described adoption factors based on DOI and TOE (Type I). In general, some researchers showed the potential of blockchain to improve information-sharing capability. Accordingly, blockchain can exchange timely, complete, reliable, and accurate information among interoperable partners' ISs. Some others investigated the adoption of blockchain to improve operational transparency, traceability, visibility, and coordination of firms. Improving these operational capabilities increases the

Table 6
Gregor's (2006) theory types for investigating the blockchain operational applications.

Category	Theory	Article	Gregor's (2006) theory taxonomy		Blockchain operational applications				
			Type	Research questions under investigation	Information sharing	Transparency, traceability & visibility	Coordination	Adaptability, agility, velocity, flexibility & resilience	Operational analytics
Adoption	ARCS	Behl et al., 2022	IV	How will the drivers of blockchain use improve supply chain performance?	×	×			
	DOI	Chen et al., 2021; Toufaily et al., 2021	I	What are the factors affecting the adoption of blockchain in supply chains? In private and public sectors?	×	×	×		×
		Karamchandani et al., 2020; Liu, Ji, & Wei, 2022; Nath et al., 2022	IV	What are the factors affecting the adoption of blockchain in the supply chain? How will the factors affect? How will blockchain adoption promote collaborative product innovation in the supply chains?		×	×		
	FVM	Liang et al., 2021	IV	What are the factors affecting the adoption of blockchain in the medical and financial industries? How will the factors affect?		×			×
	SENS	Wang, Singgih, et al., 2019	I	What are blockchain's perceived benefits for the supply chains? Where are disruptions mostly likely to occur?	×	×			
	TAM	Bracci et al., 2022; Chowdhury et al., 2022; Hashimy et al., 2022; Kamble et al., 2019; Karamchandani et al., 2020; McNamara & Sepasgozar, 2020; Ullah et al., 2022; Yang, 2019	IV	What are the factors affecting the adoption of blockchain in supply chains? In small and medium enterprises (SMEs)? In maritime shipping supply chains? In Spanish firms? In construction sector? In financial institutions? How will the factors affect?	×	×		×	×
	TOE	Chen et al., 2021; Gökalp et al., 2020; Toufaily et al., 2021	I	What are the factors affecting the adoption of blockchain in supply chains? In private and public sectors?	×	×	×		×
		Caldarelli et al., 2021; Guan et al., 2023; Hashimy et al., 2022; Nandi et al., 2021; Nath et al., 2022; Oguntegbe et al., 2022; Wong, Leong, et al., 2020	IV	What are the factors affecting the adoption of blockchain in supply chains? In Spanish firms? How will the factors affect?	×	×		×	
	TRI	Kamble et al., 2019; McNamara & Sepasgozar, 2020	IV	How will blockchain inhibit an environment of opportunistic adversarial action in supply chains? In construction sector?		×			×
	TTF	Choudhury et al., 2023	IV	How will blockchain overcome	×	×		×	

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Table 6 (continued)

Category	Theory	Article	Gregor's (2006) theory taxonomy		Blockchain operational applications				
			Type	Research questions under investigation	Information sharing	Transparency, traceability & visibility	Coordination	Adaptability, agility, velocity, flexibility & resilience	Operational analytics
Organizational economic view	UTAUT	Afifa et al., 2022	IV	shortcomings of existing traditional platforms and bridge the task fulfillment gaps in the truck freight marketplace? What are the factors affecting the adoption of blockchain in accounting? <i>How will the factors affect?</i>	×				
	AT	Han et al., 2023	IV	<i>How will</i> blockchain reduce information asymmetry in accounting and auditing?		×			
		Liu et al., 2021	V	<i>How to</i> innovate a traditional supply chain finance BMs by integrating blockchain to reduce information asymmetry?	×				
	CT	Kollmann et al., 2020	II	<i>How</i> can using the blockchain realize cooperative principles on electronic marketplaces?	×	×			
	SIG	Treiblmaier & Garaus, 2023; Ying et al., 2023	IV	<i>How will</i> signaling effects of blockchain-based traceability reduce information asymmetry in consumers' perceptions of product quality in supply chains?		×			
Resource-based theories	DC	Kusi-Sarpong et al., 2022; Lambourdiere & Corbin, 2020; Sheel & Nath, 2019	IV	<i>How will</i> blockchain affect supply chain transparency, adaptability, agility, alignment and performance?		×		×	
	RBV	Karamchandani et al., 2021; Nandi et al., 2020; Nandi et al., 2021; Nigam et al., 2022; Sharma et al., 2022	IV	<i>How will</i> blockchain affect the supply chain operational capabilities and performance? <i>How will</i> blockchain be a resource for building trust in pre-owned goods' marketing? <i>Will</i> blockchain-enabled resources possessed by firms build resilience capabilities in supply chains?	×	×	×	×	
		Martinez et al., 2019	V	<i>How to</i> code a blockchain programme with in-house resources in customer order management?					×
	RDT	Nandi et al., 2021	IV	<i>How will</i> blockchain-enabled resources acquired by firms build resilience		×		×	

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Table 6 (continued)

Category	Theory	Article	Gregor's (2006) theory taxonomy		Blockchain operational applications				
			Type	Research questions under investigation	Information sharing	Transparency, traceability & visibility	Coordination	Adaptability, agility, velocity, flexibility & resilience	Operational analytics
	RV	Dubey et al., 2020	IV	capabilities in the supply chains? <i>How will</i> blockchain enhance resilience within a humanitarian supply chain setting?				×	
	OIPT	Dubey et al., 2020; Sangal et al., 2022	IV	<i>How will</i> blockchain influence transparency, information sharing and transaction processing in supply chains? In healthcare industry?	×	×			×
		Cerchione et al., 2023; Martinez et al., 2019	V	<i>How to</i> implement a blockchain-based system to improve information sharing, transaction processing, and flexibility in supply chains? In health and medical sectors?	×			×	×
Social theories	SET	Wang et al., 2022	II	<i>How do</i> stakeholders exchange resources and create value on blockchain-enabled supply chain finance?	×	×			
		Sadeghi et al., 2022	IV	<i>How will</i> blockchain facilitate the healthcare information management?	×				
Sociomateriality	ANT	Schneider et al., 2020	II	<i>Why do</i> blockchain-based BMs and ecosystems evolve? <i>Who</i> are the heterogeneous actors involved?	×	×			
Other	Syst	Mangla et al., 2021	II	<i>How can</i> blockchain transparently establish the relationships of a supply chain system?		×			
		Zelbst et al., 2020	IV	<i>How will</i> the integration of blockchain with other technologies as subsystems of a trading system, impact supply chain transparency?		×			
	VDM	Rajnak & Puschmann, 2021	IV	<i>How banks will</i> be able to exploit and maximize business value from blockchain-enabled BMs?		×			
		Bauer et al., 2020	V	<i>How to</i> create true business value from a decentralized car ledger?	×				

satisfaction, self-confidence, mass customization, reliable delivery, sustainable practices, and task fulfillment of businesses. Some researchers found that the adoption of blockchain for risk management and continuity of business practices in emergency situations can improve *firms'*

adaptability, resilience and flexibility. Also, researchers investigated under the improvement of which internal or external resources and capabilities blockchain can enhance the *resilience capabilities of the firms*. Finally, others considered blockchain adoption as an important infrastructure

Table 7
Gregor's (2006) theory types for investigating the blockchain behavioral applications.

Category	Theory	Article	Gregor's (2006) theory taxonomy		Blockchain behavioral applications			
			Type	Research questions under investigation	Performance monitoring	Reduce lock-in effects	Task programmability & incentives	Trust & commitments
Adoption	DOI	Chen et al., 2021; Toufaily et al., 2021	I	What are the factors affecting the adoption of blockchain in supply chains? In private and public sectors?	×	×	×	×
		Liu, Ji, & Wei, 2022; Nath et al., 2022	IV	What are the factors affecting the adoption of blockchain in supply chains? <i>How will</i> the factors affect? <i>How will</i> blockchain adoption promote collaborative product innovation in the supply chains?				×
	INT	Tan et al., 2022	V	How to use blockchain for halal food traceability?	×		×	
	SENS	Wang, Singgih, et al., 2019	I	What are blockchain's perceived benefits for the supply chains?	×	×	×	×
	SDT	Behl et al., 2022	IV	How will the drivers of blockchain use improve supply chain performance?				×
	TAM	Bracci et al., 2022; Das, 2020; McNamara & Sepasgozar, 2020; Ullah et al., 2022	IV	What are the factors affecting the adoption of blockchain in SMEs? In financial institutions? <i>How will</i> the factors affect? <i>How will</i> smart contract adoption alter the trust in inter-firm cooperation?			×	×
	TOE	Chen et al., 2021; Gökalp et al., 2020; Toufaily et al., 2021	I	What are the factors affecting the adoption of blockchain in supply chains? In private and public sectors?	×	×	×	×
		Nath et al., 2022	IV	What are the factors affecting the adoption of blockchain in supply chains? <i>How will</i> the factors affect?				×
	TRI	McNamara & Sepasgozar, 2020	IV	How will a smart contract inhibit an environment of opportunistic action?			×	×
	TTF	Choudhury et al., 2023	IV	How will blockchain overcome shortcomings of existing traditional platforms and bridge the task fulfillment gaps in truck freight marketplace?	×	×	×	×
UTAUT	Afifa et al., 2022; Queiroz et al., 2021; Wong, Tan, et al., 2020	IV	What are the factors affecting the adoption of blockchain in supply chains? In accounting? <i>How will</i> the factors affect?			×	×	
Organizational economic view	AT	Beck et al., 2018; Meier & Sannajust, 2021; Murray et al., 2021; Chaudhuri et al., 2021; Han et al., 2023; Sun et al., 2020	II	How can smart contract change the contracting and corporate governance?	×	×	×	×
			IV	How will blockchain affect agency characteristics like information asymmetry, outcome uncertainty, task programmability, and outcome measurability in supply chains? In insurance? <i>How will</i> blockchain-enabled accounting and auditing inhibit an opportunistic adversarial action?	×		×	×
		Liu et al., 2021; Tan et al., 2022	V	How to innovate a traditional supply chain finance BMs by integrating blockchain to reduce information asymmetry? <i>How to</i> implement blockchain-based halal food traceability systems?	×		×	
	CT	Kollmann et al., 2020	II	How can using the blockchain realize cooperative principles on electronic marketplaces?	×	×		×
	PRT	Meier & Sannajust, 2021; Schneider et al., 2020	II	How can blockchain help exchange property rights in a business ecosystem?			×	
	TCE	Chen et al., 2022; Dal Mas et al., 2020; Meier & Sannajust, 2021; Murray et al., 2021	II	How can blockchain improve efficient governance in global value chains? <i>How can</i> smart contracts enable sustainable BMs and corporate governance?	×	×	×	×

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Table 7 (continued)

Category	Theory	Article	Gregor's (2006) theory taxonomy		Blockchain behavioral applications			
			Type	Research questions under investigation	Performance monitoring	Reduce lock-in effects	Task programmability & incentives	Trust & commitments
Resource-based		Ahluwalia et al., 2020; Denter et al., 2023; Long et al., 2022; Pereira et al., 2019; Roeck et al., 2020; Schmidt & Wagner, 2019; Sun et al., 2020	IV	How will blockchain transform the transaction costs in startup financing? In insurance? How will blockchain reduce opportunistic behaviors to support trust and sustainable practices in supply chains? How will blockchain support patent management?	×	×	×	×
	MCCT	Chen, 2019	II	How do signals from different channels be used to reduce information asymmetry about innovative blockchain ventures in ICOs?		×		
	MDT	Nguyen & Nguyen, 2022	IV	How will the decentralized nature of blockchain platforms affect the market value of developers?		×		
	SIG	Campino et al., 2022; Fisch, 2019; Hackober & Bock, 2021; Nguyen & Nguyen, 2022; Piñeiro-Chousa et al., 2021; Xu et al., 2022; Ying et al., 2023	IV	How will firms send signals to attract partners to their blockchain projects in initial coin offering (ICOs)? How will signaling effects of blockchain-based traceability impact consumers' purchase intentions? How will trustworthiness signals of blockchain implementation develop trust in supply chains?	×		×	×
	DC	Sheel & Nath, 2019	IV	How will blockchain improve supply chain trust and performance?			×	×
	PBT	Rehman Khan et al., 2022	IV	How will blockchain-enabled circular economy practices improve sustainable practices and organizational performance?	×			
	RBV	Hackober & Bock, 2021; Nigam et al., 2022	IV	How will the interplay of traditional and blockchain funding sources influence on the success of blockchain-based firms? How will blockchain, as a special IT resource, improve trust and performance of pre-owned goods' marketplaces?			×	×
	RDT	Guan et al., 2023	IV	How will the factors of blockchain adoption reduce the dependency of resource-constrained supply chain partners to leading firms?			×	
	RV	Xu et al., 2022	IV	How will be the signaling effects of blockchain implementation to the relational governance and trust in the supply chains?				×
	OIPT	Dubey et al., 2020; Sangal et al., 2022	IV	To what extent will blockchain facilitate information processing to build trust in supply chains? In healthcare industry?				×
Social theories	SCT	Galati, 2022; Liu, Li, et al., 2022	IV	How will the members' social capital affect their active participation and commitment in blockchain-based online communities? How will the social capital affect blockchain adoption in supply chains?				×
	SET	Wang et al., 2022	II	How do stakeholders exchange resources and create value through blockchain-enabled supply chain finance? How value is created for all stakeholders under the influence of blockchain-driven enablers?		×	×	×
	SIT	Schückes & Gutmann, 2021	II	What factors and how they influence on social identities and funding decisions of startup founders to use ICOs?	×	×	×	×
	SPT	Dal Mas et al., 2020	II	How can smart contracts increase social trust and foster social proof			×	×

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Table 7 (continued)

Category	Theory	Article	Gregor's (2006) theory taxonomy		Blockchain behavioral applications			
			Type	Research questions under investigation	Performance monitoring	Reduce lock-in effects	Task programmability & incentives	Trust & commitments
Sociomateriality	AA-lens	Du et al., 2019	II	behaviors to develop sustainable BMs? What are the affordances of blockchain for fintech firms? How do the fintech firms actualize these affordances?	×		×	
		Szabó et al., 2022	V	What are the affordances in blockchain-based financial recommendations? How to actualize these affordances?			×	
	ANT	Islam et al., 2019; Schneider et al., 2020	II	Why do blockchains split? Who are the heterogeneous actors involved? How do they enable a range of novelties, efficiency gains, and lock-in effects to transform BMs and ecosystems?	×	×	×	×
	FAM	Choudhury et al., 2023	IV	How will firms appropriate social structures to blockchain features to achieve higher performance in truck freight marketplace?				×
Trust-based theories	TST	Sangal et al., 2022	IV	How will blockchain facilitate information processing and trust in healthcare industry?				×
	TBMT	Nigam et al., 2022	IV	To what extent will blockchain influence on building trust and increasing performance in pre-owned goods' marketplaces?				×
	TTT	Shao et al., 2022	IV	How will blockchain be used to enhance trust in blockchain-enabled platforms? What are the trust targets in the blockchain-enabled platforms? How will the multi-targets of trust influence individuals' behavioral intention?				×
Other	POT	Liu, Li, et al., 2022	IV	How will members' share capital affect their active commitment in a blockchain-based online community?			×	×
	Syst	Campino et al., 2022	IV	How will firms reduce information asymmetry in blockchain-based ICOs to create lock-in effects?			×	
		Mangla et al., 2021	II	How will blockchain develop sustainability goals in a dynamic supply chain system?	×		×	×

for improving firms' operational analytics capabilities, resulting in accurate and rapid decision-making about business processes based on blockchain ledger's data.

In the second category of Table 6, i.e., the organizational economic view, researchers using AT showed blockchain can innovate traditional BMs to reduce information asymmetry in an agency. In this regard, the researchers prescribed that blockchain can boost firms' information sharing and transparency capabilities by improving the information acquisition component in traditional BMs to reduce hidden information (Type V). In addition, based on AT, researchers explained and predicted that blockchain can reduce information asymmetry in auditing practices by improving transparency and traceability capabilities (Type IV). Using CT, researchers explained how blockchain-enabled information sharing and transparency could realize democracy and equity principles of cooperative marketplace (Type II). Based on SIG, researchers explained and predicted how blockchain-based traceability capabilities, as signals of product quality, can affect consumers' purchase intentions. They argued that the signaling effects of using blockchain, which imply improving transparency capability and reducing information asymmetry, affect consumers' perception of product quality (Type IV).

In the third category of Table 6, i.e., resource-based theories, the identified literature investigated the effects of blockchain on

operational-level capabilities and performance of the firms. Using RBV and DC, researchers explained and predicted that blockchain can enhance the performance of firms by improving firms' information sharing, traceability, and visibility (Type IV). Besides, RBV and RDT were used to explain and predict that internal or external resources and capabilities empowered by blockchain boost the resilience capability of the firms in crises (Type IV). Based on DC, some researchers explained and predicted that blockchain could improve the adaptability of business rules and routines, product delivery agility, and resilience in the face of unstable environments (Type IV). In addition, RV was borrowed to explain and predict that blockchain could raise the firms' resilience capabilities of operational recovery in unexpected events by improving relational cooperation and trust (Type IV). Based on OIPT, researchers explained and predicted that blockchain could increase organizational information processing capacity by enhancing firms' information sharing and transparency (Type IV). Others prescribed how blockchain should be implemented to establish connections among firms' information sharing, transparency, analytics capability, and flexibility (Type V).

In the fourth category of Table 6, i.e., social theories, using SET, researchers found blockchain motivates the stakeholders of a business for transparency and sharing their information. They explained or predicted that stimuli such as the perception of high levels of information

Table 8
Gregor's (2006) theory types for investigating the blockchain implementation considerations applications.

Category	Theory	Article	Gregor's (2006) theory taxonomy							
			Type	Research questions under investigation	Management support & awareness	Supportive environment	Human/cognitive capital	Structural capital	Relational capital	Blockchain platform selection & evaluation
Adoption	BRT	Oguntegebe et al., 2022	IV	What are the factors affecting the adoption of blockchain in supply chains? <i>How will the factors affect?</i>	×	×				
	DOI	Hartley et al., 2022; Karamchandani et al., 2020; Nath et al., 2022	IV	What are the factors affecting the adoption of blockchain in supply chains? <i>How will the factors affect?</i>	×	×	×	×	×	
	FLT	Mu et al., 2019	IV	How will the online leadership affect the success of blockchain-enabled open collaborative innovation?				×		×
	FVM	Liang et al., 2021	IV	What are the factors affecting the adoption of blockchain in medical and financial industries? <i>How will the factors affect?</i>	×	×			×	
	HCT	Salcedo & Gupta, 2021	IV	What are the factors affecting bitcoin-like blockchain currencies? <i>How will the factors affect?</i>			×			×
	INT	Hartley et al., 2022	IV	How will supply chain partners adopt blockchain under external institutional pressures?			×			×
	OVT	Perdana et al., 2021	II	How can blockchain diffusion be interpreted, legitimized, and mobilized?			×	×		
	SENS	Wang, Singgih, et al., 2019	I	What are blockchain's perceived challenges for the supply chains?	×	×				
	TAM	Chowdhury et al., 2022; Hashimy et al., 2022; Kamble et al., 2019; Karamchandani et al., 2020; McNamara & Sepasgozar, 2020; Yang, 2019	IV	What are the factors affecting the adoption of blockchain in supply chains? In Spanish firms? What are the factors affecting the adoption of intelligent contracting? <i>How will the factors affect?</i>	×	×			×	×
	TOE	Gökalp et al., 2020	I	What are the factors affecting the adoption of blockchain in supply chains?	×			×	×	×
		Caldarelli et al., 2021; Clohessy &	IV	What are the factors affecting the	×	×	×			×

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Table 8 (continued)

Category	Theory	Article	Gregor's (2006) theory taxonomy							
			Type	Research questions under investigation	Management support & awareness	Supportive environment	Human/cognitive capital	Structural capital	Relational capital	Blockchain platform selection & evaluation
	TPB	Acton, 2019; Hashimy et al., 2022; Nath et al., 2022; Oguntegbe et al., 2022; Wong, Leong, et al., 2020 Kamble et al., 2019	IV	adoption of blockchain in supply chains? In Ireland? In Spanish firms? <i>How will</i> the factors affect? What are the factors affecting the adoption of blockchain in supply chains-Indian context? <i>How will</i> the factors affect?						×
	TRI	Kamble et al., 2019; McNamara & Sepasgozar, 2020	IV	What are the factors affecting the adoption of blockchain in supply chains? What are the factors affecting the adoption of intelligent contracting? <i>How will</i> the factors affect?		×				×
	UTAUT	Afifa et al., 2022; Queiroz & Wamba, 2019; Queiroz et al., 2021; Wong, Tan, et al., 2020	IV	What are the factors affecting the adoption of blockchain in accounting? In supply chains? <i>How will</i> the factors affect?	×	×		×	×	×
Organizational economic view	AT	Chaudhuri et al., 2021	IV	What are the behavioral mechanisms needed to reduce supply chain risks through blockchain projects? <i>How will</i> these mechanisms reduce risks?						×
Resource-based theories	ICV	Kusi-Sarpong et al., 2022	IV	<i>How will</i> the intellectual capital contribute to implement blockchain-driven supply chain?				×	×	×
	RBV	Karamchandani et al., 2021	IV	What is the origin of perception of improvement in blockchain-based supply chains – awareness of blockchain benefits or the blockchain hype? <i>How will</i> the awareness or the hype affect blockchain adoption?	×				×	
Social theories	SNT	Queiroz & Wamba, 2019	IV	<i>How will</i> the blockchain-enabled trust enforce supply chain relational capitals?						×
		Bai et al., 2021	V	<i>How</i> to select the best blockchain service vendor and platform using						×

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Table 8 (continued)

Category	Theory	Article	Gregor's (2006) theory taxonomy							
			Type	Research questions under investigation	Management support & awareness	Supportive environment	Human/cognitive capital	Structural capital	Relational capital	Blockchain platform selection & evaluation
	SCT	Liu, Li, et al., 2022; Galati, 2022	IV	social network relationships? <i>How will members' social capital affect their active participation in blockchain communities? How will the social capital affect intention to adopt blockchain in supply networks?</i>				×	×	×
	SET	Wang et al., 2022	II	<i>How do stakeholders exchange resources and create value through blockchain-driven supply chain finance?</i>			×			
Sociomateriality	AA-lens	Du et al., 2019	II	<i>How can fintech managers actualize the organizational affordances of blockchain?</i>			×			
Other	Syst /SoS	Hong & Hales, 2021	V	<i>How to propose a holistic assessment model for blockchain performance in the supply chains?</i>						×

security and receiving rewards such as reducing information asymmetry and acquiring digital coins through blockchain-based ISs can influence stakeholders' intention for exchanging their information (Type II, IV).

In the fifth category of Table 6, i.e., sociomateriality, researchers using ANT asked how and why the coexistence of blockchain-enabled *information sharing and transparency* and peer communities affects the activity systems of the firms (Type II). According to the last category of Table 4, i.e., other, Syst was used to explain and predict how will blockchain, radio frequency identification, and Internet of things technologies, as subsystems of a trading system, synergistically affect the *transparency capability* of a business network (Type IV). Also, Syst was borrowed to explain how blockchain improves *transparency and traceability* in a business system (Type II). Additionally, VDM was applied to enquire about how will blockchain affects the value disciplines of firms. The researchers explained and predicted that blockchain-enabled *transparency capability* could realize one of the most common value disciplines, namely operational excellence, by reducing the operational costs of organizations (Type IV). One of the studies based on *blockchain-enabled information sharing capability* has prescribed guidelines for achieving operational excellence discipline (Type V).

Table 6 shows that questions falling into investigating the effects of blockchain on adaptability, agility, velocity, flexibility, resilience, coordination and analytics capabilities for inter-firm relationships have received limited attention, especially in relation to theory Types II and V. Accordingly, the following potential research questions are raised. We propose some promising theories to address these questions. *What are the potentials of blockchain in dynamic capabilities building, such as adaptability, agility, velocity, flexibility and resilience capabilities?* (Type I)—using ANT, DC, OIPT, and RV. *How can blockchain impact organizational dynamic capabilities (e.g., adaptability, agility, velocity, flexibility and resilience) to improve operational excellence of the firms?*

(Type II)—using DC, OIPT, PBT, RV, TST, and VDM. *How and to what extent will blockchain shift static operations management toward dynamic capabilities such as operational adaptability, agility, velocity, flexibility and resilience?* (Type IV)—using DC, MCCT, OIPT, RV, and TST. *How can blockchain affect organizational information processing capacity (analytics capability) and task uncertainties?* (Type II)—using ANT, DC, MDT, OIPT, and SPT. *How to create blockchain-enabled information processing systems to maximize performance of the firms?* (Type V)—using ANT, OIPT, PBT, and RV. *What are the benefits of blockchain adoption for business stakeholder coordination* (Type I) and *how does blockchain affect coordination among business stakeholders?* (Type II)—using CT, RBV, RDT, SIT, ST, TST, and TTT.

5.4. Theory types for investigating the blockchain behavioral applications

In Table 7, a range of theories is presented in different categories that have been used in the literature to study behavioral issues of blockchain applications. In the following, the four behavioral issues are highlighted in italics.

According to the adoption category of Table 7, researchers use DOI, SENS, SDT, TAM, TOE, TRI, TTF, and UTAUT to examine what factors affect blockchain adoption (Type I) and how the factors will affect (Type IV). Results showed that improving external authority *monitoring/supervision* is essential factor of blockchain adoption. The usefulness of blockchain-based network effects for decentralizing ecosystems leads to *reduction in lock-in effects* to third-parties and the more chance of finding organizational tasks that are more fit with the features of this technology. Also, *Task programmability* by eliminating human errors in the interpretation of contracts can affect the adoption of blockchain. In addition, guaranteeing *trust and commitment* drives blockchain adoption to improve inter-firm cooperation and collaborative product innovation.

Moreover, INT was used to prescribe how blockchain-enabled *monitoring and task programming* of norms and rules can help the legitimacy of firms under external pressures (Type V).

In the organizational economic category of Table 7, researchers using AT, CT and TCE explained or predicted how blockchain could create efficient governance and cooperative marketplace, transform agency and transaction costs, and inhibit opportunistic actions to support sustainable business practices (Type II and IV). In this regard, the researchers showed that, first, blockchain could improve *the performance monitoring* of trading partners. Besides, since blockchain facilitates ex-ante monitoring to evaluate the performance of actors in their previous contracts, it contribute to choose less risky partners. Also, blockchain provides conditions for ex-post monitoring and performance evaluation of partners during the execution of existing contracts to reduce information asymmetry. Secondly, blockchain can reduce *lock-in effects* to opportunistic partners or third parties for the following reasons: (1) Blockchain-enabled decentralized management and control of business transactions eliminate the need for centralized governance of third parties; (2) Blockchain-enabled ad-hoc and cooperative markets facilitate finding suitable partners and reduces the risk of investing in specific assets of opportunistic partners; (3) Since smart contracts can facilitate the reallocation of scarce assets through tokenization, asset specificity and lock-in effects are diminished; (4) Blockchain-enabled trust replaces the activities of third parties to build trust; and (5) Network effects caused by the transparency of transactions and crypto-incentives motivate firms to lock-in to the blockchain platforms instead of third parties. Thirdly, smart contracts can guarantee appropriate business behaviors through *task programmability* and parameterizing stakeholder rights. Smart contracts can implement a behavior-influencing new incentive mechanism to measure accountability and motivate desirable behavior. Fourthly, blockchain-enabled security, transparency, traceability, immutability, and automation of transactions build the high levels of *trust and commitment* and reduce opportunistic cooperative behaviors. In addition, AT was used to prescribe how the *task programmability* of smart contracts could improve the process management component in traditional BMs (Type V). Furthermore, solutions for implementing tracking systems based on a smart contract-enabled *performance monitoring and task programmability* were prescribed to solve the problems of product compliance with legal requirements (Type V). Also, the researchers using SIG explained and predicted how a firm could make potential partners or consumers depend on its blockchain platform by sending informative signals and reducing information asymmetry to reduce *their lock-in to traditional platforms* (Type IV). In this regard, some researchers argued that blockchain-enabled *performance monitoring* as a signal of product quality can affect consumers' purchase intention. Others found that firms could disclose information about the success of their blockchain platforms by signaling technical white papers, high-quality source code, token valuations, human capital characteristics, and the reputation of the investors. In particular, concerning private blockchain platforms, researchers were argued that owners are more willing to increase developer lock-in to their platforms by sending voluntary signals on social networks. Also, SIG was used to explain and predict how blockchain implementation could act as a signal of guaranteeing *trust and commitment* among partners (Type IV). In this regard, MCCT was applied to explain how different communication channels affect the signal effects of innovative blockchain ventures in different ways (Type II). The results showed that the distinct features of channels in terms of information schema, source credibility and communication direction have different effects on information asymmetry and *lock-in* to blockchain project. Moreover, MDT was borrowed to explain and predict that the reduction in economic *lock-in effects* to traditional platforms results from open-source developers' participation in the design of decentralized blockchain platforms (Type IV). PRT was applied to explain that actors can exchange property rights using smart contracts with *task programmability* and predefined execution rules (Type II).

In the resource-based category of Table 7, researchers explained and predicted how blockchain will promote the performance of firms (Type IV). In this regard, using RBV and DC, blockchain was introduced as a special IT resource that can build *trust and commitment* in the business ecosystem by reducing asymmetry, distortion, and forging of information. In addition, using DC, the results showed that as blockchain allows firms to swiftly change their partners for greater adaptability with market needs, their *lock-in* to opportunistic actors is diminished. From the perspective of RBV, the interplay of traditional assets and blockchain can be useful for the success and *economic lock-in effects* of blockchain-based firms. Using RDT, researchers argued that blockchain adoption factors could reduce resource-constrained partners' *lock-in to leading opportunistic firms* by improving the strategy of aligning interests with suppliers. Besides, RV was used to evaluate how the interplay of emergent blockchain governance and conventional relational norms can develop inter-firm *trust and commitment*. Researchers found that although blockchain bypasses the long social process of relational norms to develop trust, its inherent limitations could reduce its performance as a governance mechanism. In this situation, relational norms governance becomes increasingly important, especially in high technology uncertainties. PBT was applied to explain and predict how blockchain-enabled *performance monitoring* and evaluation of environmental and social circumstances could guarantee sustainable business practices and performance. Using OIPT, researchers indicated the effects of blockchain-enabled organizational information processing capabilities on building *trust and commitment*.

In the category of social theories from Table 7, researchers using SCT explained and predicted that in a blockchain community, social capital such as relational *trust and commitment* will affect the willingness to adopt blockchain and develop the community (Type IV). SET was used to explain why and how business stakeholders exchange resources and create value through blockchain (Type II). In this respect, researchers explained that all stakeholders are motivated to join the blockchain platform because, firstly, the *task programmability* of smart contracts facilitates and secures information exchange processes, and secondly, blockchain-driven *trust and commitment* are enablers of effective inter-firm cooperation in value creation. SIT was used to explain what factors affect the social identity and decisions of blockchain startup founders, and how (Type II). The findings showed that social identities and decisions of startup founders concerning blockchain are often influenced by (1) ability to control rights and *performance monitoring*, (2) *reducing lock-in* to intermediated community building, (3) *task programmability and token incentivization*, and (4) value creation through democratized *trust and commitment*. In addition, SPT was used to explain that blockchain-enabled social proof *trust and commitment* are the result of *task programmability* of smart contracts (Type II).

In the sociomateriality category of Table 7, researchers argued why blockchain-based networks evolve, what the role of heterogeneous actors involved, and how this heterogeneity cause novelty, efficiency, and lock-in effects in networks. Firstly, researchers using AA-lens and ANT explained the potential of the ledger artifact in improving *performance monitoring*, which results from an audit trail of previous transaction records and helping to identify suitable partners (Type II). Secondly, ANT explained the role of actors in creating blockchain-enabled network effects and *reduction in lock-in* to intermediaries (Type II). For example, ledger-enabled information transparency and the distribution of decision-making power among all actors add to the attractiveness of blockchain-based networks. Thirdly, based on AA-lens and ANT, the affordance of *task programmability* was pointed out, which the smart contract artifact provides to reduce the manual activities of organizational actors and create new business opportunities (Type II). In addition, the affordances of smart contracts for *task programmability and tokenization* were explained to develop recommendation systems, and the necessary actions for their actualization were prescribed (Type V). Fourthly, using ANT (Type II) and FAM (Type IV), *trust and commitment* were explained or predicted as outcomes of appropriating blockchain

artifacts and as replacements for institution-based trust. For example, consensus mechanisms and ledger artifacts can create democratized trust, and smart contract can build deterrence-based trust.

In the trust-based category of Table 7, studies explained and predicted how blockchain can build *trust and commitment* in a business network (Type IV). Using TST and TBMT, researchers evaluated trust building under the influence of blockchain benefits such as operational transparency, information sharing, and transaction processing. In addition, TTT provided an appropriate theoretical foundation for understanding how firms create a nomological trust network in blockchain contexts that encourages users to engage in trust-related behaviors. In this network, trust in blockchain technology strengthens interpersonal trust among stakeholders and institutional trust in the platform instead of replacing them.

In the last category of Table 7, i.e., other, researchers using POT explained and predicted how sharing capitals or economic tokens held by users affect their active participation behavior in blockchain communities (Type IV). In this respect, researchers found that users are community owners who have *trust and commitment* to community development by receiving blockchain-enabled economic *token incentivization*. Also, researchers using Syst conceptualized blockchain projects that include projects' promoter, external partners, and open system relationships. Researchers explained and predicted that effective signaling of project information by promoters and receiving feedback from external partners leads to system adaptation to the environment and more economic *lock-in effects* of blockchain projects (Type IV). Additionally, Syst provided a basis to explain the effects of blockchain on a dynamic business system and its constituent functions with the aim of developing sustainability (Type II). Sustainability is developed through better *monitoring and task programmability* of product movements in a business system to improve *trust and commitment* among business functions.

According to the research gaps seen in Table 7, future research along with the proposed theories can further explore *what* are the interrelationships between internal and external stakeholder benefits in blockchain adoption? *What* are the influences on blockchain adopters, their co-operators, and their competitors? (Type I)—using CT, MDT, SCT, SIT, SNT, ST, SoS, Syst, and TTT. *How and to what extent will* the blockchain-enabled transaction processing reduce uncertainty and lead to a reduced number of opportunistic relationships among stakeholders? (Type IV)—using MDT, OIPT, SPT, and TTF. *How to* create blockchain solutions that maximize trust and commitments among business stakeholders? (Type V)—using AA-lens, ANT, AT, FAM, MDT, POT, SCT, and TTT. *How to* design smart contracts that enhance task programmability and incentivization of trading partners? (Type V)—using ANT, AT, MDT, POT, PRT, SDT, and SET.

5.5. Theory types for investigating the blockchain implementation considerations applications

Table 8 presents theories in different categories that have studied the considerations of implementing blockchain in business. In the following, six considerations/issues related to blockchain implementations are marked in italics.

In the adoption category of Table 8, researchers using BRT, DOI, FLT, FVM, HCT, INT, OVT, SENS, TAM, TOE, TPB, TRI, and UTAUT investigate what factors affect the behavior of blockchain adoption and implementation? How can/how will the factors affect? (Type II, IV). The researchers found that *top management support and awareness about blockchain* values and risks positively affect blockchain adoption. Also, developing a *supportive environment* and receiving any regulatory support and facilities from the government, such as tax incentives, on blockchain transactions can legitimize this technology in organizations. Standardization and entrepreneurial organizational cultures also provide a *supportive environment* for more mobilization of blockchain. In addition, at the national level, the creation of *supportive environment* and

cultural values of masculine/performance-oriented, collectivist, less uncertainty avoidance, and long-term orientation affect the more willingness to adopt blockchain. Institutional coercive pressures from regulations in relation to the necessity of visibility of product origin in business processes also as a *supportive environment* increases the willingness to adopt blockchain. On the other hand, it is important that the following capitals are provided - often as facilitation conditions - for more awareness and adoption of blockchain: (1) *Human capital*, i.e. improving blockchain expertise, for example through working with third-party consultants or more technical contributions of project leaders; (2) *Cognitive capital*, through communities' interpretations to shape the shared vision of blockchain; (3) *Structural capital*, e.g., equipped with fully integrated value chain and updated cloud-based ISs; and (4) *Relational capital*, characterized by social influence, trading partners' pressure, internal and external social capitals of project leaders, or all stakeholder proactive engagement under institutional normative pressures and more power distance values.

In the organizational economic category of Table 8, AT was used to explain and predict how will behavior-based mechanisms developed by technology service providers reduce risks in the blockchain project. The results showed that a higher level of *relational capital* could reduce behavioral risks in the business network through more customer engagement (Type IV).

In the resource-based category of Table 8, ICV was used to explain and predict the intellectual capital needed to integrate blockchain solutions into a business network. Results showed that the implementation of blockchain requires high levels of all three intellectual capitals, that is, *human, structural, and relational* (Type IV). Also, RBV was applied to explain and predict the indirect effects of blockchain's perceived benefits as an RBV resource on incremental profitability. The results showed that blockchain's perceived benefits are rooted in *awareness of technical, practical, and governance issues of blockchain* (Type IV). In addition, RBV was used to explain and predict the moderating effects of integration intensity as a *structural capital* on the indirect relationship between blockchain's perceived benefits and incremental profitability (Type IV).

In the category of social theories from Table 8, SNT was borrowed to examine how to choose the *best blockchain vendor and platform* by firms involved in a business network. In this regard, a decision-making method consisting of social network relationships and differences among agents (i.e., adopting firms, blockchain infrastructure vendors, and blockchain service platform providers) was designed (Type V). Likewise, using SNT, the impact of trust - as a *relational capital* in social connections among stakeholders - on blockchain adoption was explained and predicted (Type IV). In addition, SCT was used to explain and predict how members' *cognitive, structural, and relational capital* could affect their participation in blockchain-based platforms (Type IV). Also, SET was applied to explain that the definition of standardized norms and protocols as a *supportive environment* increases the efficiency of member interactions on the blockchain platform (Type II).

In the sociomateriality category of Table 8, AA-lens was used to explain how the blockchain-associated organizational affordances could be actualized (Type II). In this regard, providing a *supportive environment* and culture of cooperation and intrapreneurship in organizational contexts were proposed as factors affecting the actualization process.

In the last category of Table 8, i.e., other, Syst and SoS were used to prescribe a *holistic blockchain platform selection and evaluation model* in an industry setting (Type V). Researchers found that blockchain affects the performance of both a business network (at the system level) and its individual trading firms (at the subsystem level). Therefore, they proposed different criteria and sub-criteria to evaluate blockchain performance in business networks and individual firms, respectively.

According to what are lacking in Table 8, future theoretical research development can further explore *what* isomorphic pressures and institutional shifts are dominant with regard to the adoption of blockchain? *What* are the interrelationships among the isomorphic pressures concerning blockchain adoption? (Type I)—using INT, SPT, SoS, and Syst.

What resources and capitals will underpin an implementation of blockchain and cause the firms to gain benefits from this technology? (Type I)—using FVM, ICV, POT, SCT, and RV. *Why* do heterogeneous responses to blockchain implementation from institutional pressures exist? *Why* organizational affordances of blockchain are actualized in a particular organization but not in others? *Which* behavioral and cognitive characteristics of that organization matter? (Type II)—using AA-lens, FLT, HCT, ICV, INT, OVT, and SCT. *How* can the involvement of business stakeholders contribute to formulate effective policies, standards, and regulatory framework for blockchain adoption? (Type II)—using HCT, INT, POT, SCT, and ST. *What* are the outcome- and behavioral-based mechanisms needed to increase social sustainability through blockchain projects? *How* can these mechanisms increase social sustainability? (Type II)—using AT. *How* to design of user incentive mechanisms in a blockchain-based online community? *How* to develop group assessment tools to incorporate individual perceptions on blockchain adoption? (Type V)— using AT, MDT, POT, SNT, SoS, and Syst.

6. Discussion

6.1. Theoretical implications

We reviewed the theories used in the literature of blockchain applications in business and management. Relatively, few studies have used theories to go beyond the conceptualization and exploration of blockchain applications and advance insights in this emergent research domain. However, as blockchain technology evolves, there is a growing need for theory-driven research that uses theoretical perspectives to gain a deeper understanding of blockchain applications. In this regard, a review of the theory-driven blockchain research provides us with an insight into what has been done, what is missing, and what is an opportunity in applying the theories. So far, a review evaluating the theories used to understand broader blockchain applications is still lacking. Previous reviews have examined the theories used in a specific blockchain domain, including supply chain (Ahmed & MacCarthy, 2022; Kummer et al., 2020; Lohmer et al., 2022; Singh et al., 2023; Vu et al., 2023; Zhu et al., 2022), general management and economics (Alkhudary et al., 2020), consumer services (Bhawna et al., 2023), tourism and hospitality industry (Jain et al., 2023), IS (Lei & Ngai, 2023), and PoW-based blockchain applications' environmental consequences (Sapra et al., 2023). Therefore, the theoretical insights on blockchain applications have not been comprehensive. Among them, except for the three reviews that focused entirely on theory (i.e., Ahmed & MacCarthy, 2022; Kummer et al., 2020; Zhu et al., 2022), the others centered on a range of blockchain-related research themes, with less in-depth insights offered by the theories used (e.g., Alkhudary et al., 2020; Lei & Ngai, 2023). Therefore, the reviews mostly had a lack of an in-depth analysis of the theories. In addition, only two theory classification are presented, within some applicability areas of theories, including within ADO framework (Zhu et al., 2022) and intra-organizational, inter-organizational, technical, and external environment categorization (Ahmed & MacCarthy, 2022). However, the taxonomization portion of the types (forms) of theory used in the literature does not exist. Specifically, the reviews did not scrutinize whether the theories were primarily analytic, explanatory, predictive, explanatory and predictive, or prescriptive. For example, the reviews did not clarify the extent to which the theories are analysis type without actually examining the relationships among phenomena or explanatory type providing causal reasoning. Determining the types of theory used can signify the system of research questions - about what, how, why, when, where, what will be, and how to do - that have structured the literature to understand blockchain applications; and that have been under-researched or overlooked.

This study seeks to fill the above gaps through a theory review of broader blockchain applications. Our overall guidelines can be valuable in developing middle-range theories that can be used to more specific blockchain research domains. When reviewing the literature, we found

46 theories that evaluate blockchain-related 5 application areas and 26 associated issues—behavioral-oriented applications (esp., building trust and commitment in inter-firm relationships) as the most frequent and strategic-oriented as the least (esp., improving customer intimacy). Also, adopting Gregor's (2006) taxonomy, we guide blockchain researchers in the use of different types of theory to understand blockchain application areas and issues. The review shows that the types of analytical (I), explanatory (II), explanatory and predictive (IV), and design and action (IV) theories have been employed to understand blockchain applications. In this regard, we found the explanatory and predictive theories (IV) are as extensive in the blockchain literature—none of the literature have utilized the predictive type (III) of theory. Accordingly, the research questions falling into the types IV have received more attention in the literature, especially “how and what will be”. Subsequently, the theoretical statements often showed both causal reasoning and testable propositions (hypotheses) about blockchain application issues.

Generally, since blockchain applications for business and management are still relatively immature, the use of adoption decision theories is a more likely contribution of current research (See Fig. 2). However, we expect more theories with diverse perspectives to be used over time as blockchain applications mature. In this sense, more strategic-focused concepts such as customer intimacy and customer integration will likely be evaluated more, and therefore, resource-based theories (e.g., resource-based view of the firm and practice-based view theory) and especially trust-based theories (trust-based marketing theory and trust transfer theory) will likely be more important as well. In addition, more prescription may be made on the economic costs incurred for firms in reducing smart contracts' bargaining efforts, inflexibility and oracle problems—especially using economic lenses (e.g., agency theory), sociomateriality views (affordance-actualization and actor-network theory) and systems theory. Another set of theories include those with social perspectives such as social exchange theory, social identity theory, social network theory, and social proof theory can help evaluate social interactions and group decisions of multiple actors under the influence of blockchain characteristics.

At this time, the theories were expected to fall mainly into Type IV because of the high frequency of adoption theories that explain and predict the factors influencing the intention to use new technologies. Theories that give carefully any ascriptions of causality (Type II) will likely not occur until greater mature blockchain case studies (i.e., case study research method). In contrast, theories that provide propositions with causal terms that can be tested by future more practical developments (Type IV) are the more likely occur. However, since our identified theories incorporate organizational and management perspectives rather than facilitating blockchain modeling, operationalization, and implementation, we expected few prescriptive theories (Type V). Also, we expect more analysis theories (Type I) when unknown areas of blockchain applications emerge that need to be classified their specific dimensions or characteristics.

To clarify our theoretical contribution, we compare our proposed research questions with two previous review articles that focus the most on theory (i.e., Kummer et al., 2020; Zhu et al., 2022). Kummer et al. (2020) and Zhu et al. (2022) posed each research question for each of their identified theories. In contrast, we suggested at least one promising theory for each question. Accordingly, diverse theoretical insights can be generated for a common research question. Furthermore, we suggested research questions separately for each of the blockchain application areas and types of Gregor's (2006) theory taxonomy. Therefore, we inform researchers about which research topic/area and the theory types needed for a new academic project. Most of the questions presented by Kummer et al. (2020) and Zhu et al. (2022) stimulate the use of theories to analyze, explain, or predict blockchain applications (Types I, II, and IV). Thus, these two reviews—unlike ours—significantly neglected to encourage the use of theories for the design and action of blockchain applications (Type V).

Overall, the future academic projects require diverse theoretical

perspectives and different types (forms) of theory to be involved. We acknowledge that there are other useful theories, beyond those identified in the blockchain literature (See Fig. 2) to address our proposed questions. For example, adaptive structuration theory, similar to ANT and AA-lens from the sociomateriality category, can be used to conceptualize social structures as emerging from the interactions of both human and non-human actors. Also, role theory as a social conformation perspective can be added to the category of social theories. This theory contributes to understand the social influence on blockchain adoption decisions. Transaction utility theory, having a potential economic view, can provide new insights for blockchain adoption. In addition, the synthesis of demand theory and consumer behavior theories with adoption models can contribute to understand the effects of environmental factors concerning market structure, demand characteristics, and customer needs on blockchain adoption. Furthermore, the synthesis of resource-based theories with knowledge management and learning theories can enhance the understanding of blockchain's effects on inter-firm information sharing capabilities. For the questions posed for Gregor's (2006) Type V, in particular, the use of analytical modeling frameworks such as game theory, regret theory, queueing theory, mean-risk theory, intuitionistic fuzzy theory, and Metcalfe's law can contribute to methodological evaluation of the theories in use. Besides, normalization process theory and process virtualization theory are two potential theories that can be utilized to design business practices and processes in blockchain implementations. Table 9 shows potential future directions of theory applications in blockchain literature. Potential research questions are presented in reference to Gregor's (2006) theory types—except Type III, which is more common in the natural sciences than in the social sciences. They are a summary of the questions raised in Sections 5.1 to 5.5. We propose promising theories to address the questions—among the 46 theories reviewed in the literature and those recommended in this section.

6.2. Practical implications

This study shows specific blockchain applications areas and issues that have been explored so far. Managers and practitioners who are interested in knowing about the motivations, decisions and outcomes of adopting blockchain in business and management can gain insights from this study. Findings show that present blockchain applications are more-oriented toward improving operational (esp., transparency, traceability and visibility of processes) and behavioral (esp., trust and commitment) areas of business and management. In terms of economic implications, we found that blockchain applications result in both benefits (esp., lower performance monitoring efforts) and costs (esp., higher verification and storage efforts). Blockchain also provides several strategic-level outcomes, such as decentralizing the relational structure and improving integration and collaborations with partners. In addition, providing the necessary relational, structural and human capitals and top management support are some of the considerations of blockchain implementation for business and management. The study presents such insights as categorized concepts, causal reasoning, predicted outcomes, or prescribed principles. According to the findings, managers and practitioners can acquire the right competence to utilize blockchain efficiently and effectively. Furthermore, the proposed future research questions show that some more specific investigations on the potentials and challenges of blockchain are necessary for practical use cases.

7. Conclusion and limitations

The importance of using theories to understand blockchain applications can help advance both theoretical and practical developments in business and management. As blockchain business use cases increase, more empirical evidence is provided to apply and test theories. In this research, a systematic review of blockchain literature provides us insights into what theories have been used, what blockchain-related

Table 9
Potential future directions for theory-driven blockchain research.

Gregor's (2006) theory types	Potential research questions	Proposed theories
Type I	1. <i>What are the effects of blockchain-induced technological costs on blockchain adoption?</i>	Agency theory, demand theory, sensemaking theory, technology readiness index, transaction cost economics, transaction utility theory
	2. <i>What are the potentials of blockchain in dynamic capabilities building, such as adaptability, agility, velocity, flexibility and resilience capabilities?</i>	Actor-network theory, adaptive structuration theory, dynamic capabilities, knowledge management and learning theories, organizational information processing theory, relational view of competitive advantage
	3. <i>What are the benefits of blockchain adoption for business stakeholder coordination?</i>	Cooperative theory, resource-based view of the firm, resource dependence theory, social identity theory, stakeholder theory, theory of swift trust, trust transfer theory
	4. <i>What are the interrelationships between internal and external stakeholder benefits in blockchain adoption? What are the influences on blockchain adopters, their co-operators, and their competitors?</i>	Cooperative theory, mechanism design theory, role theory, social capital theory, social identity theory, social network theory, stakeholder theory, system of systems theory, systems theory, trust transfer theory
	5. <i>What isomorphic pressures and institutional shifts are dominant with regard to the adoption of blockchain? What are the interrelationships among the isomorphic pressures concerning blockchain adoption?</i>	Institutional theory, social proof theory, system of systems theory, systems theory
	6. <i>What resources and capitals will underpin an implementation of blockchain and cause the firms to gain benefits from this technology?</i>	Fit-viability model, intellectual capital based view, psychological ownership theory, social capital theory, relational view of competitive advantage, role theory
Type II	7. <i>How are disputed transactions related to the inflexibilities of smart contracts resolved in the absence of third-party intervention?</i>	Agency theory, system of systems theory, systems theory
	8. <i>How can blockchain improve customer-focused performance of firms? How can blockchain characteristics interplay with customer cognition and purchase intention? How can blockchain fundamentally alter the nature and quality of customer integration?</i>	Actor-network theory, consumer behavior theories, organizational information processing theory, organizing vision theory, practice-based view theory, resource-based view of the firm, self-determination theory, social proof theory, trust-based marketing theory, trust transfer theory, value disciplines model
	9. <i>How can blockchain impact organizational dynamic capabilities (e.g., adaptability, agility, velocity, flexibility and resilience) to improve operational excellence of the firms?</i>	Adaptive structuration theory, dynamic capabilities, knowledge management and learning theories, organizational information processing theory, practice-based view theory, relational view of competitive advantage, theory of swift trust, value disciplines model

(continued on next page)

Table 9 (continued)

Gregor's (2006) theory types	Potential research questions	Proposed theories
Type IV	10. How can blockchain affect organizational information processing capacity (analytics capability) and task uncertainties?	Actor-network theory, dynamic capabilities, mechanism design theory, organizational information processing theory, social proof theory
	11. How does blockchain affect coordination among business stakeholders?	Cooperative theory, resource-based view of the firm, resource dependence theory, social identity theory, stakeholder theory, theory of swift trust, trust transfer theory
	12. Why do heterogeneous responses to blockchain implementation from institutional pressures exist? Why organizational affordances of blockchain are actualized in a particular organization but not in others? Which behavioral and cognitive characteristics of that organization matter?	Adaptive structuration theory, affordance-actualization, functional leadership theory, Hofstede's cultural theory, intellectual capital based view, institutional theory, organizing vision theory, social capital theory
	13. How can the involvement of business stakeholders contribute to formulate effective policies, standards, and regulatory framework for blockchain adoption?	Hofstede's cultural theory, institutional theory, psychological ownership theory, role theory, social capital theory, stakeholder theory
	14. What are the outcome- and behavioral-based mechanisms needed to increase social sustainability and reduce quality, financial and human risks through blockchain projects? How can these mechanisms increase social sustainability and reduce risks?	Agency theory, fuzzy theory, mean-risk theory
	15. How will the blockchain lead to transactional efficiencies and shifts in competitive power?	Practice-based view theory, resource-based view of the firm, resource dependence theory, relational view of competitive advantage, transaction cost economics, transaction utility theory
	16. How will blockchain reduce the transaction costs for horizontal and vertical stakeholders?	Cooperative theory, system of systems theory, systems theory, transaction cost economics
	17. How and to what extent will blockchain shift static operations management toward dynamic capabilities such as operational adaptability, agility, velocity, flexibility and resilience?	Dynamic capabilities, knowledge management and learning theories, multiple-channel communication theory, organizational information processing theory, relational view of competitive advantage, theory of swift trust
	18. How and to what extent will the blockchain-enabled transaction processing reduce uncertainty and lead to a reduced number of opportunistic relationships among stakeholders?	Mechanism design theory, organizational information processing theory, social proof theory, task-technology fit
	19. How to address the bargaining costs currently faced by blockchain platforms? How to design blockchain solutions that minimize lock-in to the oracles' data sources? How to design smart contracts that	Actor-network theory, adaptive structuration theory, affordance-actualization, agency theory, system of systems theory, systems theory, transaction cost economics

Table 9 (continued)

Gregor's (2006) theory types	Potential research questions	Proposed theories
Type V	are more flexible against contingencies?	
	20. How to push the structure of an organization from hierarchies toward electronic customer-focused markets on blockchain?	Adaptive structuration theory, cooperative theory, Hofstede's cultural theory, intellectual capital based view, normalization process theory, process virtualization theory, transaction cost economics
	21. When will collusion happen in a blockchain-enabled business system and how to avoid such possibilities through blockchain splitting?	Actor-network theory, adaptive structuration theory, functional leadership theory, psychological ownership theory, system of systems theory, systems theory
	22. How to create blockchain-enabled information processing systems to maximize performance of the firms?	Actor-network theory, adaptive structuration theory, organizational information processing theory, practice-based view theory, queueing theory, relational view of competitive advantage
	23. How to create blockchain solutions that maximize trust and commitments among business stakeholders?	Actor-network theory, affordance-actualization, agency theory, fit-appropriation model, mechanism design theory, psychological ownership theory, social capital theory, trust transfer theory
	24. How to design smart contracts that enhance task programmability and incentivization of trading partners?	Actor-network theory, agency theory, game theory, mechanism design theory, psychological ownership theory, property rights theory, self-determination theory, social exchange theory
	25. How to design of user incentive mechanisms in a blockchain-based online community? How to develop group assessment tools to incorporate individual perceptions on blockchain adoption?	Agency theory, fuzzy theory, game theory, mechanism design theory, normalization process theory, psychological ownership theory, social network theory, system of systems theory, systems theory
26. How to design a model to evaluate the blockchain platform?	Fuzzy theory, system of systems theory, systems theory, regret theory	

application areas and issues have been affected, and what types of Gregor's (2006) theory taxonomy have been employed. Adopting Gregor's (2006) taxonomy provides a guide to identify a system of future research questions that can be used to explore blockchain applications. We consider theories that hold substantive promise for advancing answers to these research questions. We found that there are still many issues of blockchain applications that need to be addressed by using different types of Gregor's (2006) theory taxonomy.

The following limitations can provide further research opportunities. First, we excluded several articles that focus on theories with analytical modeling characteristics, such as game theory, chaos theory, queueing theory, and intuitionistic fuzzy theory. Because, in line with Zhu et al. (2022), we believe that these theories are meant more for completing analytical methodological analyses of studies and for methodological evaluation rather than theory development. By excluding these articles, the theories that are especially served as the Type V of Gregor's (2006) taxonomy were not evaluated. In doing so, some areas and issues related to blockchain applications may also be left out. Future research can evaluate how these analytical theoretical frameworks can contribute to

explore blockchain applications. Second, we included only theory-driven blockchain research published in Scopus-indexed journals. Future research can examine a sample of the most relevant articles indexed in other databases to check whether the types of Gregor's (2006) theory taxonomy and the blockchain applications explored in those articles are consistent with what are presented in this research. In case of non-compliance, researchers can discuss the differences and consequences. Third, the limited number of theory-driven blockchain articles led us to collect and analyze the literature at the conceptual and empirical levels. Over time, blockchain with a more mature set of practical use cases is likely to expand theory-driven empirical research. Therefore, a number of additional and perhaps distinct insights into blockchain applications and theory taxonomization are likely to generate as blockchain matures, which could complete our current results. We invite researchers to use future empirical data for theory taxonomization in the blockchain domain and compare their resulting insights with the findings of this study.

Appendix A

Table A.1

Themes table for blockchain application areas (i.e. main themes) and issues (i.e., sub-themes).

Main themes	Sub-themes	Blockchain articles
Economic applications	Lower search and information costs	Ahluwalia et al., 2020; Chen et al., 2022; Dal Mas et al., 2020; Hasan et al., 2020; Karamchandani et al., 2020; Karamchandani et al., 2021; Roeck et al., 2020; Schmidt & Wagner, 2019; Schneider et al., 2020; Sun et al., 2020; Wang, Luo, & Lee, 2019
	Lower monitoring costs	Ahluwalia et al., 2020; Chen et al., 2022; Dal Mas et al., 2020; Hasan et al., 2020; McNamara & Sepasgozar, 2020; Pereira et al., 2019; Rehman Khan et al., 2022; Roeck et al., 2020; Schmidt & Wagner, 2019; Schneider et al., 2020; Sun et al., 2020; Toufaily et al., 2021; Wang, Luo, & Lee, 2019; Wang, Singgih, et al., 2019; Zhang et al., 2021
	Lower bargaining costs (under lower environmental uncertainties)	Hasan et al., 2020; McNamara & Sepasgozar, 2020; Schmidt & Wagner, 2019
	More bargaining costs (under higher environmental uncertainties)	Beck et al., 2018; Chen et al., 2022; Sun et al., 2020
	Inflexibility costs of smart contracts	Beck et al., 2018; Das, 2020; McNamara & Sepasgozar, 2020; Meier & Sannajust, 2021; Murray et al., 2021; Roeck et al., 2020; Toufaily et al., 2021
	Control costs of oracles	Meier & Sannajust, 2021; McNamara & Sepasgozar, 2020; Murray et al., 2021; Pereira et al., 2019; Sun et al., 2020; Wang, Singgih, et al., 2019
	Verification and storage costs	Beck et al., 2018; Bracci et al., 2022; Guan et al., 2023; Jabbar & Dani, 2020; Queiroz & Wamba, 2019; Murray et al., 2021; Pereira et al., 2019; Toufaily et al., 2021; Wong, Leong, et al., 2020
Strategic applications	Integration and alignment of firms	Behl et al., 2022; Chen et al., 2021; Choudhury et al., 2023; Chowdhury et al., 2022; Galati, 2022; Guan et al., 2023; Islam et al., 2019; Kamble et al., 2021; Long et al., 2022; Nandi et al., 2020; Sheel & Nath, 2019; Toufaily et al., 2021
	Collaboration and innovativeness of firms	Bauer et al., 2020; Chen et al., 2021; Das, 2020; Dubey et al., 2020; Han et al., 2023; Liu et al., 2021; Liu, Ji, & Wei, 2022; Nandi et al., 2020; Schneider et al., 2020; Rajnak & Puschmann, 2021; Toufaily et al., 2021
	Customer intimacy	Bauer et al., 2020; Chen et al., 2021; Hashimy et al., 2022; Rajnak & Puschmann, 2021; Toufaily et al., 2021; Wang, Luo, & Lee, 2019
	Decentralized relational structure	Beck et al., 2018; Chen et al., 2021; Choudhury et al., 2023; Dal Mas et al., 2020; Das, 2020; Denter et al., 2023; Kollmann et al., 2020; Liu et al., 2021; Schmidt & Wagner, 2019; Pereira et al., 2019; Schücker & Gutmann, 2021; Sun et al., 2020; Toufaily et al., 2021; Wang, Luo, & Lee, 2019; Wang, Singgih, et al., 2019
Operational applications	Information sharing of firms	Affa et al., 2022; Bauer et al., 2020; Behl et al., 2022; Caldarelli et al., 2021; Cerchione et al., 2023; Chen et al., 2021; Choudhury et al., 2023; Chowdhury et al., 2022; Guan et al., 2023; Lambourdiere & Corbin, 2020; Liu et al., 2021; Kollmann et al., 2020; Nandi et al., 2020; Sadeghi et al., 2022; Sangal et al., 2022; Sharma et al., 2022; Schneider et al., 2020; Toufaily et al., 2021; Wang, Singgih, et al., 2019; Wang et al., 2022; Yang, 2019
	Operational transparency, traceability and visibility of firms	Behl et al., 2022; Bracci et al., 2022; Caldarelli et al., 2021; Chen et al., 2021; Choudhury et al., 2023; Chowdhury et al., 2022; Dubey et al., 2020; Gökalp et al., 2020; Guan et al., 2023; Han et al., 2023; Kamble et al., 2019; Karamchandani et al., 2020; Karamchandani et al., 2021; Kollmann et al., 2020; Kusi-Sarpong et al., 2022; Lambourdiere & Corbin, 2020; Liang et al., 2021; Liu, Ji, & Wei, 2022; Mangla et al., 2021; Nandi et al., 2021; Nath et al., 2022; Nigam et al., 2022; Oguntegbe et al., 2022; Rajnak & Puschmann, 2021; Schneider et al., 2020; Sharma et al., 2022; Toufaily et al., 2021; Treiblmaier & Garaus, 2023; Ullah et al., 2022; Wang, Singgih, et al., 2019; Wang et al., 2022; Wong, Leong, et al., 2020; Yang, 2019; Ying et al., 2023; Zelbst et al., 2020
	Operational coordination of firms	Lambourdiere & Corbin, 2020; Liu, Ji, & Wei, 2022; Nandi et al., 2020; Toufaily et al., 2021
	Operational adaptability, agility, velocity, flexibility and resilience of firms	Dubey et al., 2020; Cerchione et al., 2023; Choudhury et al., 2023; Chowdhury et al., 2022; Hashimy et al., 2022; Martinez et al., 2019; Nandi et al., 2021; Sharma et al., 2022; Sheel & Nath, 2019
	Operational analytics of firms	Cerchione et al., 2023; Dubey et al., 2020; Liang et al., 2021; Martinez et al., 2019; McNamara & Sepasgozar, 2020; Sangal et al., 2022; Toufaily et al., 2021

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CRedit authorship contribution statement

Payam Hanafizadeh: Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Conceptualization. **Maryam Alipour:** Writing – original draft, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

None.

Data availability

Main data generated or analyzed during this study are included in this article.

Table A.1 (continued)

Main themes	Sub-themes	Blockchain articles
Behavioral applications	Performance monitoring	Chaudhuri et al., 2021; Chen et al., 2021; Chen et al., 2022; Choudhury et al., 2023; Du et al., 2019; Han et al., 2023; Liu et al., 2021; Kollmann et al., 2020; Mangla et al., 2021; Murray et al., 2021; Rehman Khan et al., 2022; Roeck et al., 2020; Schmidt & Wagner, 2019; Schneider et al., 2020; Schücker & Gutmann, 2021; Tan et al., 2022; Toufaily et al., 2021; Treiblmaier & Garaus, 2023; Wang, Singgih, et al., 2019; Ying et al., 2023
	Reduce lock-in effects	Ahluwalia et al., 2020; Beck et al., 2018; Campino et al., 2022; Chen, 2019; Chen et al., 2021; Chen et al., 2022; Choudhury et al., 2023; Denter et al., 2023; Fisch, 2019; Guan et al., 2023; Hackober & Bock, 2021; Islam et al., 2019; Kollmann et al., 2020; Schmidt & Wagner, 2019; Murray et al., 2021; Nguyen & Nguyen, 2022; Pereira et al., 2019; Piñeiro-Chousa et al., 2021; Roeck et al., 2020; Schneider et al., 2020; Schücker & Gutmann, 2021; Sheel & Nath, 2019; Sun et al., 2020; Toufaily et al., 2021; Wang, Singgih, et al., 2019; Wang et al., 2022
	Task programmability and incentives	Ahluwalia et al., 2020; Beck et al., 2018; Chaudhuri et al., 2021; Chen et al., 2022; Choudhury et al., 2023; Dal Mas et al., 2020; Das, 2020; Denter et al., 2023; Du et al., 2019; Han et al., 2023; Liu et al., 2021; Mangla et al., 2021; McNamara & Sepasgozar, 2020; Meier & Sannajust, 2021; Murray et al., 2021; Queiroz et al., 2021; Pereira et al., 2019; Schmidt & Wagner, 2019; Schneider et al., 2020; Schücker & Gutmann, 2021; Sun et al., 2020; Szabó et al., 2022; Tan et al., 2022; Toufaily et al., 2021; Wang, Singgih, et al., 2019; Wang et al., 2022
	Trust and commitments	Affifa et al., 2022; Ahluwalia et al., 2020; Behl et al., 2022; Bracci et al., 2022; Chen et al., 2021; Choudhury et al., 2023; Das, 2020; Dal Mas et al., 2020; Denter et al., 2023; Dubey et al., 2020; Du et al., 2019; Galati, 2022; Gökalp et al., 2020; Han et al., 2023; Liu, Ji, & Wei, 2022; Liu, Li, et al., 2022; Long et al., 2022; Mangla et al., 2021; McNamara & Sepasgozar, 2020; Nigam et al., 2022; Nath et al., 2022; Queiroz & Wamba, 2019; Queiroz et al., 2021; Roeck et al., 2020; Sangal et al., 2022; Schücker & Gutmann, 2021; Shao et al., 2022; Sheel & Nath, 2019; Toufaily et al., 2021; Ullah et al., 2022; Wang, Singgih, et al., 2019; Wang et al., 2022; Xu et al., 2022
Blockchain implementation considerations	Top management support and awareness about blockchain	Caldarelli et al., 2021; Clohessy & Acton, 2019; Gökalp et al., 2020; Hashimy et al., 2022; Karamchandani et al., 2020; Karamchandani et al., 2021; Liang et al., 2021; Nath et al., 2022; Oguntegbe et al., 2022; Wong, Tan, et al., 2020; Wong, Leong, et al., 2020; Wang, Singgih, et al., 2019; Yang, 2019
	Supportive environment	Caldarelli et al., 2021; Du et al., 2019; Hartley et al., 2022; Liang et al., 2021; McNamara & Sepasgozar, 2020; Nath et al., 2022; Oguntegbe et al., 2022; Perdana et al., 2021; Salcedo & Gupta, 2021; Wang et al., 2022; Wong, Tan, et al., 2020; Yang, 2019
	Human/cognitive capital	Clohessy & Acton, 2019; Galati, 2022; Gökalp et al., 2020; Hartley et al., 2022; Kusi-Sarpong et al., 2022; Liu, Li, et al., 2022; Mu et al., 2019; Perdana et al., 2021; Queiroz & Wamba, 2019; Queiroz et al., 2021; Wong, Tan, et al., 2020
	Structural capital	Caldarelli et al., 2021; Clohessy & Acton, 2019; Galati, 2022; Gökalp et al., 2020; Hartley et al., 2022; Karamchandani et al., 2020; Karamchandani et al., 2021; Kusi-Sarpong et al., 2022; Liang et al., 2021; Liu, Li, et al., 2022; Queiroz & Wamba, 2019; Queiroz et al., 2021; Wong, Tan, et al., 2020
	Relational capital	Affifa et al., 2022; Chaudhuri et al., 2021; Chowdhury et al., 2022; Galati, 2022; Gökalp et al., 2020; Hartley et al., 2022; Hashimy et al., 2022; Kamble et al., 2019; Kusi-Sarpong et al., 2022; Liu, Li, et al., 2022; Mu et al., 2019; Nath et al., 2022; Queiroz & Wamba, 2019; Queiroz et al., 2021; Salcedo & Gupta, 2021; Wong, Tan, et al., 2020
	Blockchain platform selection and evaluation	Bai et al., 2021; Hong & Hales, 2021

Table A.2

An overview of Gregor's (2006) theory types for investigating the blockchain application areas.

Blockchain articles	Theory	Theory types					Blockchain application areas				
		I	II	III	IV	V	Economic	Strategic	Operational	Behavioral	Implementation considerations
Affifa et al., 2022	UTAUT				×				×	×	×
Ahluwalia et al., 2020	TCE				×	×				×	
Bai et al., 2021	SNT					×					×
Bauer et al., 2020	VDM					×	×	×			
Beck et al., 2018	AT		×			×	×		×		
Behl et al., 2022	ARCS, SDT				×		×	×	×		
Bracci et al., 2022	TAM				×	×		×	×		
Caldarelli et al., 2021	TOE				×			×			×
Campino et al., 2022	SIG, Syst				×				×		
Cerchione et al., 2023	OIPT					×		×			
Chaudhuri et al., 2021	AT				×				×		×
Chen, 2019	MCCT		×						×		
Chen et al., 2021	DOI, TOE	×					×	×	×		
Chen et al., 2022	TCE		×			×			×		
Choudhury et al., 2023	TTF, FAM				×		×	×	×		
Chowdhury et al., 2022	TAM				×		×				×
Clohessy & Acton, 2019	TOE				×						×
Dal Mas et al., 2020	TCE, SPT		×			×	×		×		
Das, 2020	TAM				×	×	×		×		
Denter et al., 2023	TCE, ST				×		×		×		
Du et al., 2019	AA-lens		×						×		×
Dubey et al., 2020	RV, OIPT				×		×	×	×		
Fisch, 2019	SIG				×				×		

(continued on next page)

Table A.2 (continued)

Blockchain articles	Theory	Theory types					Blockchain application areas				
		I	II	III	IV	V	Economic	Strategic	Operational	Behavioral	Implementation considerations
Galati, 2022	SCT				×			×		×	×
Gökalp et al., 2020	TOE	×								×	×
Guan et al., 2023	RDT, TOE				×	×	×	×	×		
Hackober & Bock, 2021	SIG, RBV				×					×	
Han et al., 2023	AT, ST				×			×	×		
Hartley et al., 2022	DOI, INT				×						×
Hasan et al., 2020	TCE				×	×					
Hashimy et al., 2022	TAM, TOE				×			×	×		×
Hong & Hales, 2021	Syst, SoS					×					×
Islam et al., 2019	ANT		×					×		×	
Jabbar & Dani, 2020	TCE					×	×				
Kamble et al., 2019	TAM, TRI, TPB				×				×		×
Kamble et al., 2021	DC				×			×			
Karamchandani et al., 2020	DOI, TAM				×	×			×		×
Karamchandani et al., 2021	RBV				×	×			×		×
Kollmann et al., 2020	CT		×					×	×	×	
Kusi-Sarpong et al., 2022	DC, ICV				×				×		×
Lambourdiere & Corbin, 2020	DC				×				×		
Liang et al., 2021	FVM				×				×		×
Liu et al., 2021	AT				×			×	×	×	
Liu et al., 2022	DOI				×			×	×	×	
Liu, Li, et al., 2022	SCT, POT				×					×	×
Long et al., 2022	RDT, TCE				×			×		×	
Mangla et al., 2021	Syst		×						×	×	
Martinez et al., 2019	RBV, DC, OIPT					×			×		
McNamara & Sepasgozar, 2020	TAM, TRI				×	×			×	×	×
Meier & Sannajust, 2021	TCE, AT, PRT		×			×				×	
Mu et al., 2019	FLT				×						×
Murray et al., 2021	TCE, AT		×			×				×	
Nandi et al., 2020	RBV				×			×	×		
Nandi et al., 2021	RBV, RDT, TOE				×				×		
Nath et al., 2022	DOI, TOE				×				×		×
Nguyen & Nguyen, 2022	SIG, MDT				×				×	×	
Nigam et al., 2022	RBV, TBMT				×				×	×	
Oguntegbe et al., 2022	TOE, BRT				×				×		×
Rehman Khan et al., 2022	PBT				×	×				×	
Perdana et al., 2021	OVT		×			×					×
Pereira et al., 2019	TCE				×	×		×		×	
Piñeiro-Chousa et al., 2021	SIG				×					×	
Queiroz & Wamba, 2019	UTAUT, SNT				×	×				×	×
Queiroz et al., 2021	UTAUT				×					×	×
Rajnak & Puschmann, 2021	VDM				×			×			
Roeck et al., 2020	TCE				×	×				×	
Sadeghi et al., 2022	SET				×			×			
Salcedo & Gupta, 2021	HCT				×						×
Sangal et al., 2022	OIPT, TST				×				×	×	
Schmidt & Wagner, 2019	TCE				×	×		×		×	
Schneider et al., 2020	ANT, PRT		×			×		×	×	×	
Shao et al., 2022	TTT				×					×	
Sharma et al., 2022	RBV				×				×		
Sheel & Nath, 2019	DC				×			×	×	×	
Sun et al., 2020	TCE, AT				×	×		×		×	
Tan et al., 2022	AT, INT					×				×	
Toufaily et al., 2021	DOI, TOE	×				×		×	×	×	
Treiblmaier & Garaus, 2023	SIG				×				×	×	
Schückes & Gutmann, 2021	SIT		×							×	
Szabó et al., 2022	AA-lens					×				×	
Ullah et al., 2022	TAM				×				×	×	
Wang, Luo, & Lee, 2019	SDT				×	×		×			
Wang, Singgih, et al., 2019	SENS	×				×		×	×	×	×
Wang et al., 2022	SET, S—D logic		×					×	×	×	×
Wong, Leong, et al., 2020	TOE				×	×		×			×
Wong, Tan, et al., 2020	UTAUT				×					×	×
Xu et al., 2022	SIG, RV				×					×	
Yang, 2019	TAM				×			×			×
Ying et al., 2023	SIG				×			×	×		
Zhang et al., 2021	TCE					×	×				
Zelbst et al., 2020	Syst				×			×			

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