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Research Article

Utilizing Blockchain Technology to Manage the Dark and Bright Sides of Supply Network Complexity to Enhance Supply Chain Sustainability

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The supply network becomes more fragile as it becomes more complex, affecting the core firm's performance. While previous research on supply network complexity existence paradox. Therefore, to study the nature of supply network complexity, this paper divides the supply chain complexity utility into positive and negative valences based on the valence framework and divides supply chain complexity into supply base complexity, customer base complexity, and logistics base complexity. Based on the trustworthiness and transparency characteristics of blockchain technology, this paper investigates how to use blockchain technology to reduce the negative valence of supply chain complexity while adapting to or improving the positive valence to improve enterprise competitiveness and supply chain sustainability. As a result, the focus of this paper is on how to better manage supply chain complexity using blockchain technologies to increase supply chain sustainability and viability.

1. Introduction

Due to the outbreak of COVID-19, supply chains around the world have been disrupted to varying degrees [1, 2]. Therefore, in order to improve supply chain resilience and their ability to cope with risks, more and more studies have focused on the supply network complexity to improve the supply chain resilience [3]. Supply chain complexity management is becoming increasingly important. For the management of a complex supply chain, achieving supply chain transparency is crucial, and as supply chains become more complex, achieving supply chain transparency becomes increasingly difficult.

The network of firms is getting increasingly complex and technology-oriented, according to organizational theory, and the network of enterprises is more sensitive to accidents [4]. Perrow [5] explains why complex social technology systems fail with normal accident theory, linking the occurrence of accidents to the structure and technology of the underlying system. According to normal accidents theory, complexity is one of the key factors for a high accident rate in the social technology system. The occurrence of destructive events in a system is influenced by complexity in two ways, the first of which is related to the occurrence of destructive events in complex systems: a system with a large number of elements is likely to be more harmful than one with fewer elements [6]. The second mechanism has to do with management capacity, or the ability to recognize and prevent damaging events before or after they happen. The occurrence of catastrophic events in the supply chain can be influenced by supply chain complexity as a complex system. As a result, improving supply chain transparency is one of the most essential components in addressing the negative effects of supply chain complexity.

The supply chain firm offers a lot of potential for blockchain technology as a disruptive technology. The most significant advantage of blockchain technology in the supply chain is that it improves information exchange and transparency amongst supply networks. Blockchain technology can be utilized to accomplish whole-process monitoring and information traceability in the medical and fresh food industries [7]. Similarly, as global supply networks become

increasingly complex [8, 9], information asymmetry and uncertain risks in supply chains increase, which makes it more likely to lead to bullwhip effects and ripple effects that exacerbate the negative impact of the supply chain risks. With the increase in the number of participants in the supply network, the lack of understanding and trust between different actors is further caused [10]. Blockchain technology can assure the reliability and transparency of information transmission on the supply network and increase confidence between transaction subjects due to its inherent technical properties [11]. Therefore, blockchain technology has very high applicability in the field of supply chains [12].

In the past, many studies linked higher supply network complexity to poor firm performance, but recent research has revealed that complexity is an important factor in supply network organizations' access to survival and development space, which has a significant impact on changes in the external environment, changes within organizations, and continuous performance optimization. The ability of a network organization to manage its complexity and quickly adapt to the complexity of the external environment is critical to its existence. The purpose of this study is to use blockchain technology to manage supply chain complexity, as well as to identify the meaning and dimension of supply chain complexity, and to analyze the relationship between blockchain technology and supply chain complexity.

(1) The dimension of supply chain complexity is proposed in conjunction with the relevant study situation

(2) Previous research has found that supply network complexity has a detrimental impact; however, this study investigates the dual impact of supply network complexity

(3) What is the relationship between blockchain technology and the supply network complexity

(4) How can blockchain technology be used to respond to and adapt to the supply chain's complexity

This paper contributes to the theory in the following aspect: first, this study is based on the valence theory and put out that supply chain complexity can be divided into positive valence and negative valence and put forward that we can utilize blockchain technology to manage supply chain complexity. Second, this study put forward three propositions that utilizing blockchain technology can help manage the supply chain complexity to enhance supply chain sustainability. Third, this paper put forward that ambidexterity management of the supply network complexity by using blockchain technology, blockchain technology can be used to respond to the positive and negative valence of supply network complexity from the perspective of ambidexterity.

2. Theoretical Background

2.1. Research on Blockchain Technology in the Field of Supply Chains. By use of blockchain technology in the supply chain has raised interest recently, although the practical value of blockchain technology in dealing with supply network complexity has yet to be investigated. Blockchain, as a leading technology, is transforming and redefining the interactions between actors in logistics and supply chain networks. Some research indicates that the implementation of blockchain technology in the supply chain mitigated the negative impact of COVID-19 on companies under the impact of COVID-19 [13]. The most essential feature of blockchain technology is that it may boost the transparency of information transfer over the supply network while maintaining security [14]. The adoption of blockchain technology in the field of the supply chain can also improve the adaptability of the supply chain and thus improve enterprise performance [15]. As supply networks become more complex, supply chain pain points such as asymmetric information and supply chain risk rise. Because of the absence of trust and real-time data transmission between many stakeholders, a supply chain information system based on existing blockchain technology can improve supply chain resilience and risk level. [16]. As a technology applied in the field of the supply chain, blockchain focuses on connectivity. In the process of technology implementation, attention should be paid to factors affecting connectivity, interactions, and elasticity in the supply chain [17]. For the adoption of blockchain research, the research shows that the Unified Theory of Acceptance and Use of Technology (UTAUT) model, the Task-Technology FIT (TTF), and the Information System Success (ISS) Mode are key factors influencing the adoption of blockchain technology by supply chain employees [18]. However, there are some inhibitors to the adoption of blockchain technology in supply networks. For example, Blockchain technology is a high-cost storage medium, and its adoption is only justified when the benefits of deploying blockchain technology surpass the expenses [19]. The adoption of blockchain technology is also an excellent choice for long-term development, as it has the potential to drastically alter firm development models due to its immutability, security, credibility, and transparency. Blockchain technology will not only have a significant impact on the logistics industry, but it will also have a significant impact on business models [20]. Supply chain collaboration is another area where blockchain technology has a lot of potential. Blockchain technology has the potential to affect not just supply chain collaboration and increase trust in B2B partnerships, but also to strengthen cooperation and address vulnerability issues connected to potential risks and the negative impact of technical legacy problems [21].

Following a review of the relevant literature on blockchain technology and its use in the supply chain, it was discovered that blockchain technology has a lot of potential in the supply chain, and the technological characteristics of blockchain, such as traceability, tamper-proofing, and asymmetric encryption, may indeed provide the safe and reliable transmission of information in the supply chain to achieve the reliable. From the perspective of the increasingly complex supply network, the supply network's reliability and transparency are the initial requirements for managing a complex supply chain. This technical characteristic of

blockchain allows firms to leverage the technology to better manage the supply chain's complexity.

2.2. Supply Network Complexity. A wider choice of products, shorter product life cycles, and lower production costs are pushing enterprises to their limits, resulting in supply chain management complexity. To manage this complexity, management must understand the key complexity drivers and their inter-relationships. To manage this complexity, management must understand the key complexity drivers and their inter-relationships. The complexity of a supply network can be separated into two categories: structure and behavior complexity [6]. The former is known as structure complexity, while the latter is known as dynamic complexity (or operational complexity), and this definition has been the foundation for future studies on complexity.

Previously, the impact of supply chain network architecture on the core enterprise relationship management strategy was assessed. [22], they examined five factors that make up the supply network structure and the impact on four relationship management strategies [22]. There are also studies focusing on structural attributes of the supply chain: formalization and centralization, and the relationship between structural attributes and operational performance [23]. There is also a way to match the product structure with the supply chain structure [24]. While many studies have shown that rising supply chain complexity is linked to worse firm performance in the past, a recent study reveals that increasing supply chain complexity harms firm performance while benefiting innovation and financial performance [3]. Numerous empirical research on supply networks have shown that product diversification, multimarket, and multichannel strategies can increase a company's market performance [25]. In places with high supply chain complexity, formal and societal restraints have both negative and positive effects on operational performance, especially as supply networks become more complex [26].

The normal incident hypothesis can be used to explain how adverse event traceability happens in various supply networks since irregularities are more common in complex supply networks. The normal incident hypothesis can be used to explain how adverse event traceability happens in various supply networks since irregularities are more common in complex supply networks. [27]. Studies have identified three characteristics of supply base complexity: the number of suppliers, supplier differences, and supplier interrelationships [28, 29]. Some studies divide the supply structure complexity scale into visible and less apparent levels since many supply chain structure studies focus on network-level characteristics and overlook supply-base characteristics. Some aspects of supply network complexity amplify the impact of disruptions, while others improve resilience following disruptions [30]. Some scholars have suggested supply chain complexity can be divided into three categories: upstream, internal manufacturing, and downstream complexity [31].

To resolve the paradox of the preceding study, this study uses the valence framework to classify the supply network's complexity into positive and negative valences. The theory of value is used to explain consumer behavior and comes from the domains of economics and psychology. The valence framework proposed by Peter and Tarpey [32] takes into account both positive and negative factors on individual decision-making behavior. The core premise of the valence framework is that individuals make decisions to minimize the negative impact and maximize the positive impact [33]. As a result, we employ the valence framework to investigate the positive and negative consequences of supply network complexity. Therefore, the impact of supply network complexity is classified into positive and negative valences based on the value framework, which is utilized to explain the beneficial and harmful consequences of previous supply chain complexity research (which answer the second question). Investigating how blockchain technology can be utilized to address supply network complexity to increase the supply network's ability to adapt to risks and improve supply chain viability.

2.3. Blockchain Technology, Supply Chain Complexity, and Supply Chain Disruption. The supply chain is the process of getting the correct products to the right place at the right time, and coordination, planning, and control are the most important aspects of this process [34]. Coordination requires the establishment of systems to increase transparency throughout the supply chain. Increased supply network transparency can also help firms react quickly to shifting customer and social awareness [34]. In supply chain management, enterprises face common challenges from upstream and downstream, where they need to manage consumer and market preferences, and upstream, where they need transparency to manage their complex supply networks. Firms may not be able to determine where their Tier 1 suppliers buy or send materials, and assessing the quality of supplier products and the openness of the production and supply processes becomes more challenging if Tier 1 suppliers have many manufacturing locations around the world.

Global and local supply chains differ in terms of supply chain complexity, adaptability, and complexity. Global supply networks are more complex and flexible since they have a wider supply base to choose from. Local supply chains, on the other hand, are less complex and thus more adaptable to market changes, especially when influenced by extreme events. Supply network risks are exposed as supply chains grow in size and complexity, and effective supply chain transparency is the most important factor in controlling supply chain complexity. The continual advancement and development of modern information technology provide a good opportunity to manage the supply chain's complexity. Effective transparency policies and processes are required not simply to keep or restore supply chain partners' trust.

In terms of the relationship between blockchain technology and the supply chain, firms that use new blockchain technologies to better understand partner operations and reduce supply chain risk benefit from transparency

technologies [35, 36]. Blockchain technology can be seen as an opportunity to leverage existing supply chain resources and competitiveness, its traceability, which can be viewed as an exploration technology or a relationship-building technology, is the essential invention of blockchain technology [37]. The most significant feature of blockchain technology is traceability, which improves supply chain transparency, strengthens supply chain management, facilitates information sharing among partners, and lowers the cost of supply chain coordination, thereby improving the supply chain's ability to respond to disruption risk. As a result, integrating blockchain technology into the supply chain has a positive impact on the supply chain's viability and the competitiveness of firms [38].

3. Dimensions of Supply Network Complexity

According to previous research, supply chain complexity can have a dual effect on resilience after a supply chain interruption; on the one hand, supply chain complexity can help with recovery ability after a supply chain interruption; for example, higher supply base complexity allows firms to use more supplier after an interruption, which improves their ability to recover. On the other hand, supply chain complexity can be detrimental to recovery ability after a supply chain interruption; for example, higher supply base complexity can enable enterprises to use more suppliers after the interruption, improving their ability to recover [30]. Therefore, according to the location of the supply network, this study divides the complexity of the supply network into supply-based complexity, customer-based complexity, and logistics complexity (which response to the first question) (Figure 1).

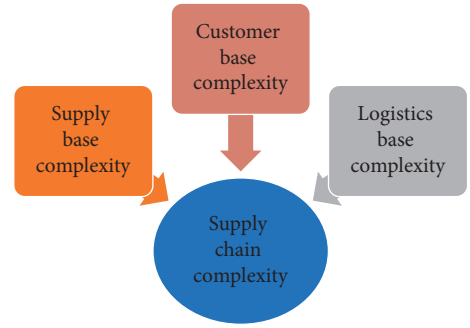

Figure 1: The dimensions of supply network complexity.

3.1. Supply Base Complexity. Increased visibility of information improves product traceability and authenticity, providing a basis for industries that need to track their products [39]. In addition, by adopting smart contracts, agreements can be automated in-network transactions [40], aiming at simplifying the supply chain process, thus improving the efficiency of the supply chain. Information sharing through blockchain technology reduces the physical movement and duplication of information and latency of files, improving inventory management and waste in the supply chain for more accurate demand forecasting [41]. The spread of digital technology has contributed to the interdependence and management activities between businesses and supply networks in the industry. Treiblmaier [41, 42] believes that blockchain solutions can change the concept of interorganization relationships by enhancing the exchange of trusted information between companies.

The complexity of the supply base increases when the core company has many suppliers that vary in geography, enterprise size, organizational culture, and technical capabilities [43, 44]. At the same time, many of these suppliers have inconsistent lead times and extended lead times, which adds to the supply base's complexity. The increasing complexity of maintaining a supply base is often accompanied by an increase in transaction costs and the number of interactions and interfaces that must be managed [29, 45]. As the supply base increases, core companies often face higher information processing requirements, accompanied by increased communication costs [43]. From a supplier heterogeneity perspective, the geographic location of different suppliers and the differences between different industries increase the burden on core enterprises to respond to different suppliers [28, 43]. Thus, as transaction costs increase, the degree of control over the supply base decreases with complexity, making it more difficult for core firms to deal with supplier opportunism [45]. In terms of communication quality, as well as the scope and timeliness of information sharing [46], managing a wide range of suppliers can frequently result in difficult-to-control situations.

The increasing complexity of the supply chain may be advantageous to company innovation. Internal and external knowledge are the two main sources of knowledge for firms [47]. Open innovation shows that companies can innovate by seeking knowledge from the outside. Knowledge-based view shows that the more actors you reach in the network, the easier it is for companies to innovate [29]. Due to the massively increased complexity of the supply base, the core firm now has a significant number of suppliers from various industries and technical capabilities, allowing it to harness knowledge from other suppliers to drive innovation [44].

3.2. Customer Base Complexity. Supply chain organizations may address a variety of consumer expectations by employing blockchain technology, quickly recalling products from the market when disrupted, automate business processes with integrated responses to product quality by tracking product chains. Supply chain complexity refers to the extent to which an organization's supply chain consists of a large number of different elements that interact in unpredictable ways [48].

Customer base complexity usually refers to downstream complexity, which is frequently associated with customer numbers and product types. A broad customer base and a wide variety of finished goods with a shorter life cycle contribute to the complexity of the customer base when the core enterprise's aims meet changing consumer needs and expectations [49]. When the complexity of the customer base is high, customers with a large deviation of customer

demand will hurt the operating efficiency of enterprises [31]. Transaction costs also increase with more and more diverse customers, reducing the efficiency of companies in managing their customer base. As customers become more geographically dispersed, it is common for core businesses to increase inventory costs and cash withdrawal cycles [50]. Furthermore, a diverse client base may compound the impact of fluctuations in demand in downstream supply chains, affecting the business's success.

3.3. Logistics Complexity. Since there are so many carriers in a supply network that represent network connectivity, there is a need for greater carrier monitoring and coordination [29]. Firms must better coordinate the multiparty entities in the supply chain to efficiently manage the complex supply network. Coordinating logistical activities among many carriers, is more challenging, as organizations must manage several partnerships among carriers, which are frequently interconnected [51]. More carriers may mean more unreliable delivery options for the core organization, as it is difficult for the core enterprise to control all carriers.

According to standard accident theory, increased logistical complexity increases the likelihood of supply chain disruption. When a high level of logistical complexity exists, managers have a better chance of discovering and diagnosing problems [52]. As a result, the number of carriers in the supply network increases, thereby increasing the complexity of logistics. Increased logistics complexity may provide a higher level of flexibility for the business after the outage [53]. When problems occur in one transportation link, enterprises can choose other carriers to ensure the continuity of transportation. When an enterprise has multiple carriers, it can quickly transfer products among carriers [54]. As a result, firms require more optional carriers to improve their ability to use logistics networks more flexibly and prevent order delays.

For firms with low logistical complexity, on-time and reliable delivery can be a problem. According to research, organizations that are not sufficiently diversified and rely too much on crucial suppliers recover more slowly from interruptions [55]. These actual cases reinforce the importance of diverse third-party logistics carriers. In the event of a disruption, the availability of alternatives allows shippers to transfer to carriers that perform better in the event of an outage at minimal conversion costs to carriers that perform better in the event [30]. In this setting, implementing a diverse portfolio of complex delivery systems can improve the firm's ability to respond to threats while also assisting the core firmly in avoiding potential risks.

4. The Relationship between Blockchain Technology and Supply Networks Complexity

One of the causes of supply chain complexity is that supply chain transparency reduces as the degree of the supply network grows. From the standpoint of transaction cost economics, it encompasses constrained rationality and opportunism. Furthermore, due to supply chain complexity creating a more uncertain environment, it is likely to enhance supplier opportunism and limit organizations' ability to detect supplier opportunism.

Xiao and Qi [56] emphasize that information sharing and good communication between multiple layers and channels are key strategies to avoid supply chain disruptions caused by fluctuations in demand. Product diversity is also an important manifestation of customer base diversity, the optimum design of a product may not be suitable for another product. Therefore, when product variety is high, more efficient supply chain coordination is required [57]. Another key factor that drives supply chain complexity is the product life cycle; a shorter product life cycle means faster supply chain design adjustments to satisfy different levels of demand uncertainty at various stages, as well as faster production and shorter lead times [58].

As seen in the following three images, we mainly employ OPEN KNOWLEDGE MAPS, a visual tool, to generate the three main themes of my research. This visualization tool generates keywords based on the metadata output of a huge amount of articles. To create keywords between articles, search terms are mostly derived from the title, abstract, author, journal, and topic keywords. Figure 2 is connected to blockchain research, Figure 3 is related to supply chain complexity, and Figure 4 is about the overlap of blockchain and supply network complexity. We can see from the key terms in these three figures that there are currently few papers that study both blockchain technology and supply chain complexity. Current research on blockchain technology and supply chain complexity are two relatively independent research streams. As a result, we assume our research into how to use blockchain technology to manage supply chain complexity has some merit.

4.1. Why Supply Chain Complexity Management Requires Visibility and Transparency. Visibility makes it easier for firms to respond to supply chain risk incidents, therefore having a high level of visibility is crucial. The danger of supply chain vulnerability grows as more stakeholders become involved in today's society, and risk management becomes increasingly important. As the supply base of the core firm becomes more complicated, the core firm will need more suppliers to strengthen its ability to respond to threats. However, as the complexity of the supply base grows, it becomes more difficult for the enterprise to control the behavior of members of the supply network, and the supply network's transparency and visibility decrease. As a result, improving supply network transparency and visibility is the most crucial thing to do to manage supply chain complexity as supply networks become increasingly complex.

Increased transparency in the supply network is not only to meet regulatory requirements but also to optimize operations, ensure product quality, and ensure the sustainability of processes [59]. Supply chain transparency solutions enable knowledge integration to improve decision quality, lowering perceived risk, and enhancing control over partner behavior, allowing for better management of supply chain complexity's negative effects. By increasing transparency

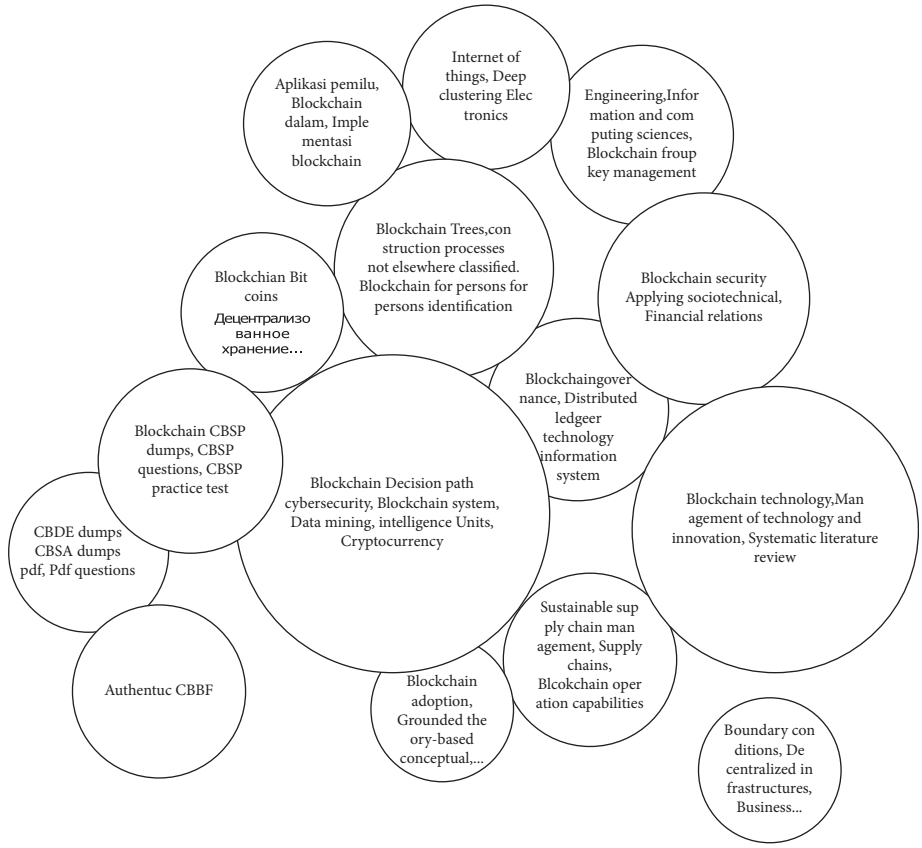

Figure 2: Overview of research on blockchain. Source: Open Knowledge Maps (2022). Overview of research on blockchain. Retrieved from https://openknowledgemaps.org/map/5f73499253c87dec9f0a22736f1bcf0b (2 Mar 2022).

between supply chain partners, the subjective perception among supply chain partners can be improved [60] and improve the trust between supply chain partners, reducing the uncertainty and inherent risk of supply chain partners' behavior [61, 62]. Supply chain transparency enables companies to establish response strategies for external and internal outages, thereby reducing operational risk [63]. Suppliers are less likely to take opportunistic or risky actions in a complex supply network as transparency rises, lowering costs and shortening production lead times. Increased accountability and control over the supply chain come from having visibility into the upstream supply base and the downstream consumer base. Furthermore, effective transparency techniques can reduce supply chain partner uncertainty as well as the supply chain's structural complexity.

4.2. Blockchain as a Governance Mechanism to Address Supply Chain Complexity. The more complex a supply chain is, the less visibility and transparency it has, and companies are dealing with a more dynamic environment, which is especially true in today's VUCA world. It is more uncertain, making it more difficult to manage a complex supply chain. The focus for core firms is on building better supply chain transparency strategies based on the existing supply chain structure, which can only change very little in a short period [64]. Complex supply chains have multiple supply chain levels, making it difficult to increase supply chain transparency alone for a single core enterprise [65], and for core enterprises, it is expensive, complex, time-consuming, and laborious to disclose ESG data of supply chain [65, 66] to control all levels of the supply chain.

4.2.1. The Relationship between Blockchain Technology and Supply Base Complexity. The number of suppliers affects the ability of core enterprises to manage suppliers and subsuppliers, thereby negatively affecting the visibility and transparency of the supply chain [67]. Through interconnectedness between supply chains, the deployment of blockchain technology in the supply chain can promote supply chain transparency and facilitate information sharing and collaboration among supply chain members. The supply chain is composed of multiple actors which may have different or conflicting goals [68]. Therefore, to address the issues, a common governance structure for supply chain members to manage supply chain partners through particular norms and agreements must be implemented. Blockchain as an information system can establish norms and governance mechanisms in the supply chain [69]. Distributed ledger technology, which provides authenticity and traceability by storing data on blocks that are difficult to tamper with, was the initial definition of blockchain technology. Blockchain technology's intrinsic nature and potential to transform organizations, industries, and supply networks [70].

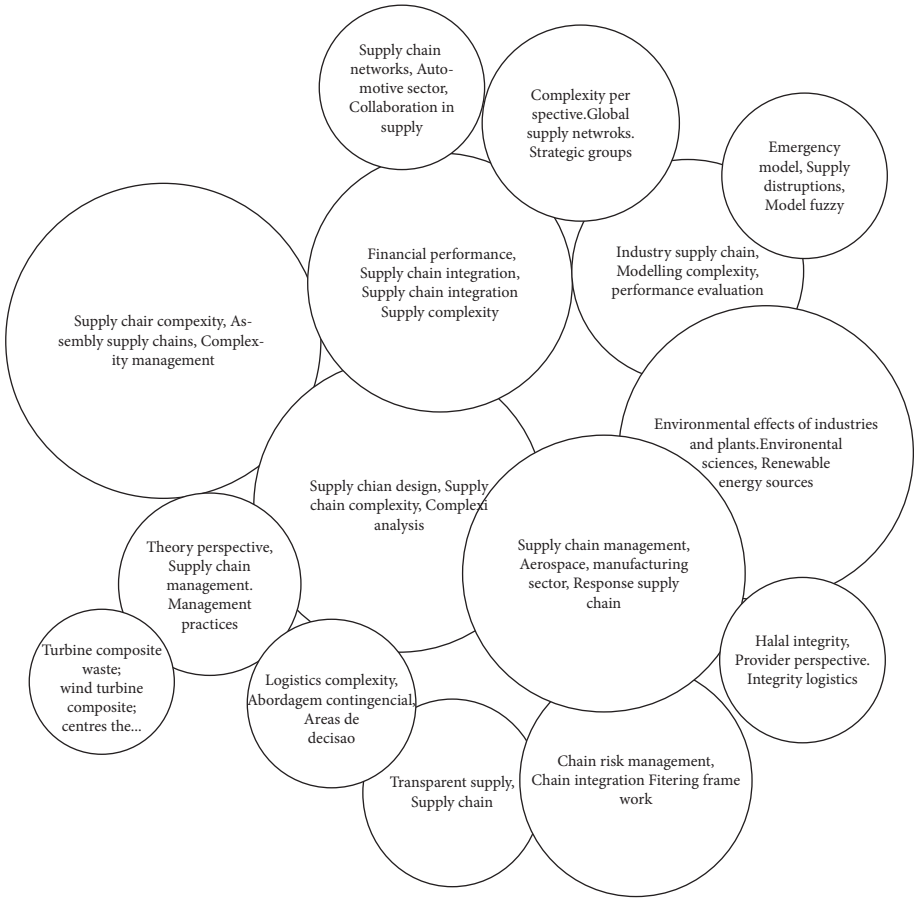

Figure 3: Overview of research on supply chain complexity. Source: Open Knowledge Maps (2022). Overview of research on supply chain complexity. Retrieved from https://openknowledgemaps.org/map/7ab5811ae0ec2eb91d0c795129953a82 (2 Mar 2022).

It gets more difficult to control and trace the flow of information in the supply chain as the supply network becomes more complicated [71, 72]. The blockchain serves as a platform to integrate and manage information from a variety of complex and multilevel participants and channels [73]. The information may be viewed in a safe environment by supply chain partners and entities, and the transparency and security of blockchain technology have a substantial impact on supply chain objectives. Blockchain technology can support supply chain management by executing smart contracts [74]. By executing smart contracts between supply chain partners, processes can be fully automated and information flows between processes can be accelerated [75]. The transparency and verifiability of blockchain information tend to reduce the need for trust between supply chain partners [76], and supply chain complexity can be better managed through coordination among supply chain partners.

Blockchain technology provides a system that connects multiple supply chains [76, 77]. Blockchain-supported governance structures make better use of the visualization of information for coordination among supply chain partners [78]. As a result, better cooperation and coordination among supply chain participants are required to better manage supply chain complexity. Blockchain technology provides a high level of transparency, which aids strategic decision-making. It may also be successfully used in modern supply networks to improve supply chain sustainability, where it is difficult to track complex data from several departments and activities across organizations [79]. Blockchain technology's information can change the supply chain's flow because of its trustworthiness, authenticity, immutability, and traceability. The use of blockchain technology can identify redundant operations or procedures in the supply chain, reducing the requirement for third parties.

Through the above analysis, we propose the following:

> H1: utilizing blockchain technology can help manage the supply base complexity to enhance supply chain sustainability.

4.2.2. The Relationship between Blockchain Technology and Logistics Base Complexity. By combining GPS and tracking devices, blockchain-based solutions provide reliable information on product delivery, distribution networks, and logistics performance [80]. The existing supply network involves various third-party logistical activities, and blockchain technology can guarantee the validity and trustworthiness of the information. Blockchain is an integrated system that connects individual supply chain entities while allowing for quick verification of required supply chain information and tracking of essential transportation data

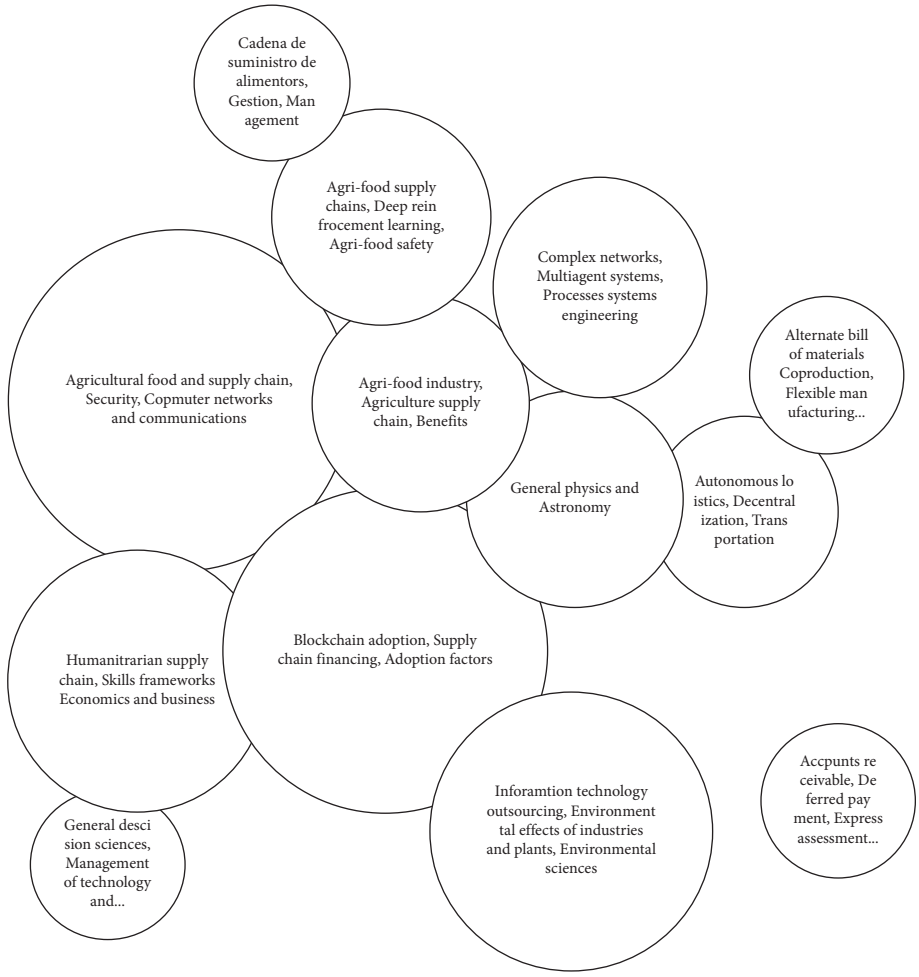

Figure 4: Overview of research on blockchain; supply chain complexity. Source: Open Knowledge Maps (2022). Overview of research on blockchain; supply chain complexity. Retrieved from https://openknowledgemaps.org/map/d8a0604af922b2eb1444eb6d5d153a75 (2 Mar 2022).

[81]. The high level of information transparency and visibility can increase the overall supply network's transparency, allowing for better supply chain management and sustainability.

Since the logistics base complexity involves both the core organization's multiple logistics carriers and logistics information complexity, blockchain technology can help the core firm better manage supply chain complexity and improve supply chain sustainability. The problem of reverse logistics should be included in the full product portfolio of products and materials life cycle, which should include recycling, repair, reuse, and renewal [82].

Blockchain technology allows for comprehensive clarification and documentation of this information. The transparency and accountability of the information provided by blockchain enable managers to compare their energy consumption and reusability of their products with other similar entities in the market, assess logistics complexity on time, to better manage negative logistics complexity, and make better use of logistics complexity and enhance supply chain sustainability.

Through the above analysis, we propose the following:

H2: utilizing blockchain technology can help manage the logistics base complexity to enhance supply chain sustainability.

4.2.3. The Relationship between Blockchain Technology and Customer Base Complexity. Blockchain technology connects downstream supply chain members, including retailers and customers, and transparency of information enables core enterprises to track product sales performance, and data can be used by all supply chain members, in which way potential difficulties in product demand and use can be observed not only by multiple members of the supply chain but also by multiple members of the supply chain, which may limit uncertainty and related issues. Blockchain is a comprehensive technology that connects end-customers with upstream suppliers, and customer claims can be recorded on blockchain ledgers where upstream suppliers can see information about those customers [81].

Applying blockchain technology to the supply chain can provide real information about market and product quality, as well as customer satisfaction and expectations. Customer

demand differentiation is an important aspect of managing supply chain complexity, while customer base complexity is the most critical customer demand. Blockchain technology can provide supply chain demand visibility from the supply side to the demand side. This results in the management of the demand chain, where end-customer demand information is visible among all partners, and blockchain technology provides flexibility for supply chain management to reduce delays and risks in the supply chain [82]. By using blockchain technology to accurately predict demand in the supply chain, inventory costs in the supply chain can be reduced, the risk of supply chain disruption can be alleviated, and the problem of client complexity and sustainability in the supply chain can be improved.

Through the above analysis, we propose the following:

H3: utilizing blockchain technology can help manage the customer base complexity to enhance supply chain sustainability.

The third question is answered by the three hypotheses stated above. The purpose of this study is to figure out how blockchain technology affects supply chain complexity. By use of blockchain to enable information and relationship governance is a key approach to dealing with the supply chain's complexity. Supply network complexity is a critical component in obtaining survival and development opportunities for supply network firms. Supply network complexity influences both external and internal organizational change and has a significant impact on achieving continual performance optimization. A network organization's ability to manage the complexity of its supply network and adapt rapidly to the complexity of the external environment is critical to its existence. As a result, an organization's competitiveness is solely determined by its capacity to manage complexity.

In sum, we mainly put forward three hypotheses about the relationship between blockchain technology and supply chain complexity. The hypotheses proposed in this study are summarized in Table 1.

5. Blockchain Technology as a Management Response to the Supply Network Complexity

This section summarizes the previous discussion of descriptive frameworks for understanding supply chain complexity management. In the first part, we draw on the study of Maylor and Turner [83], which provides a corresponding approach to the three dimensions of supply chain complexity, Maylor and Turner [83] divide supply chain complexity into three dimensions: structural dimension, socio-political dimension, and emergent dimension, where the response consists of three dimensions: planning and control, relationship development, and flexibility. The study's second section mostly relies on ambidexterity research to demonstrate how firms can leverage existing information or build and explore new knowledge to minimize supply chain complexity or adapt to it. From an exploitation standpoint, complexity can be reduced or eliminated by using appropriately known technologies, processes, or best practices; from an exploration standpoint, complexity can be reduced or eliminated by developing or introducing a new solution, and in response to supply network complexity. The benefits of complexity can be obtained from an existing solution, and the benefits of complexity can be obtained from a development perspective. Taking advantage of complexity that competitors cannot emulate.

In the area of organizational learning, March [84] proposes activities that utilize (refine and use existing knowledge) and develop (innovation, problem-solving, and drilling new knowledge), both of which compete with each other for limited organizational resources within the organization. Subsequent studies of trade-offs between development and exploitation led to a great deal of research on ambidexterity. Ambidexterity is also an important area of research in the supply chain, and some studies have shown that supply chain ambidexterity contributes to business performance, interorganizational relationships, and flexibility [85, 86]. Despite the fact that ambidexterity research has become a useful perspective for analyzing supply network performance and ambidexterity, few studies employ it to understand supply chain complexity.

Supply chain complexity has become a prominent research issue in supply chain management; yet, for the time being, the study of complexity has tended to focus on two aspects of complexity: the negative impact of complexity and the positive impact of complexity. Rather than focusing on ways to decrease or expand supply chain complexity, we divided it into two categories in this study: positive and negative. We advocate minimizing (lowering) the impact of negative values for negative valences, and maximizing the impact of complexity for positive valences by adapting or increasing the angle for positive valences. Minimization is used to cope with negative complexity, while adaptation is used to deal with positive complexity. Both ways can answer using an ambidexterity viewpoint (exploration and exploitation). Systems and processes can be put in place to help limit the impact of supply chain complexity when adopting blockchain technology as a response (which answers the fourth question). Figure 5 is our proposed ambidexterity management of supply network complexity by using blockchain technology.

Blockchain technology can be used to respond to the positive and negative valence of supply network complexity from the perspective of ambidexterity. On the one hand, blockchain technology can be used for exploitation activities to improve the function of positive valence, that is, using blockchain technology to benefit from the supply network's complexity and optimize the organizational structure. To increase supply chain members' ability to respond to supply network disruption concerns, use blockchain technology to manage supply chain members' relationships, and to facilitate collaboration among supply chain members. Also, make use of the data offered by blockchain technology to improve present products and services, as well as the current state of operations. On the other hand, blockchain technology can be used for exploration activities; that is, blockchain technology can be used in novel ways, leveraging the benefits of complexity to generate competitive

Table 1: The relationship between blockchain technology and supply chain complexity.

Number	Hypotheses description
H1	Utilizing blockchain technology can help manage the supply base complexity to enhance supply chain sustainability
H2	Utilizing blockchain technology can help manage the logistics base complexity to enhance supply chain sustainability
H3	Utilizing blockchain technology can help manage the customer base complexity to enhance supply chain sustainability

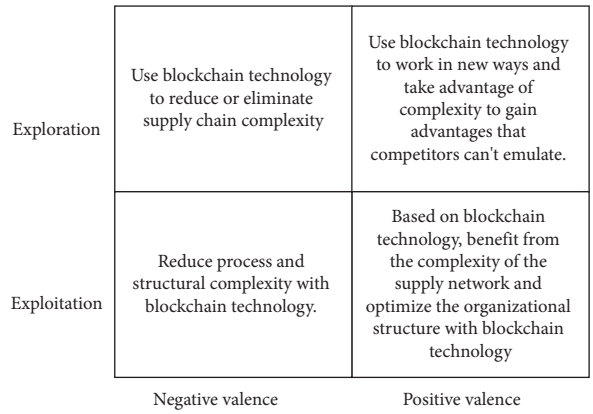

Figure 5: Ambidexterity management of the supply network complexity by using blockchain technology.

advantages that are difficult to duplicate. Blockchain technology is being used to organize resources to create value for supply chain organizations, strengthen their strategic advantage, and harness the market and customers supplied by blockchain technology to produce new products or deliver new services.

On the one hand, blockchain technology can be used to alleviate the negative valence of supply network complexity; that is, blockchain technology can be used to lessen process and structural complexity. For example, using blockchain technology to design and apply controls to describe the complexity of the negative impact would be a good example. The use of blockchain technology to efficiently coordinate production and logistics activities, as well as the use of blockchain technology to quickly explain to consumers the cause of supply network disruption and the status of supply network recovery; On the other hand, blockchain technology can be utilized in exploration activities to minimize or eliminate the negative valence effect. Using blockchain technology's transparency to respond flexibly to demand fluctuations and using blockchain technology to identify potentially problematic suppliers, carriers, and dishonest customers.

6. Conclusion

The previous study suggests that supply chain complexity can be negative to the supply chain performance, and some studies indicate that supply chain complexity can be positive to help the supply chain to improve the ability to cope with supply chain risks. To explore this question, we mainly use valence theory to divide supply chain complexity into positive valence and negative valence. Based on the previous analysis, we divide the supply network's complexity into three categories: supply base complexity, logistics base complexity, and customer base complexity. We also presented three hypotheses on the relationship between blockchain technology and supply network complexity. Then, according to the valence framework, the beneficial and detrimental features of the supply network's complexity are summarized as positive and negative valences. Simultaneously, the ambidexterity theory is discussed, as well as how to examine and apply activities to deal with the supply chain complexity of positive and negative valences using blockchain technology.

Through a systematic analysis, we show that blockchain technology in supply chain management may achieve the most crucial function of trusted transparency. Blockchain, as a governance mechanism, is often able to better understand partner activities and minimize supply chain risk by investing in emerging supply chain transparency technologies [35, 36]. Deploying technologies related to supply chain transparency, helps companies reduce search costs, and improve their reputation. The study by Lamming et al. [87] shows that different degrees of information sharing within the supply chain provides all participants with the knowledge, product source, and process information.

With the help of ambidexterity theory, using blockchain technology, the positive and negative aspects of supply chain complexity are examined and leveraged. Exploration and exploitation activities can both benefit from blockchain technology. To utilize ambidexterity by dealing with the negative valence of supply chain complexity, blockchain technology is being used to reduce process and structural complexity. The application of blockchain technology to simplify processes and structures and efficiently organize production and logistics activities; customers can be informed about the reasons for supply network disruptions and the progress of supply network recovery using blockchain technology. Employing blockchain technology to decrease or eliminate complexity while exploring features of ambidexterity, seek new suppliers, logistics carriers, and customers; identify potentially dangerous suppliers, carriers, and dishonest customers, and respond quickly to changing requirements with transparent information given by blockchain technology.

By employing ambidexterity in dealing with the positive valence of supply network complexity: Benefit from supply network complexity, use blockchain technology to optimize the organizational structure and use blockchain technology to manage relationships among supply chain members, facilitating collaboration among supply chain members and improving their ability to respond to the supply network disruption risk. Make use of the data offered by blockchain technology to improve current products and services, as well as existing operations. For the investigation of ambidexterity

disruption, by employing blockchain technology to work in new ways, the benefits of complexity to acquire competitive advantages that are difficult to duplicate; developing new products or providing new services using blockchain technology's marketplaces and customers.

From the above-given analysis, we can infer that blockchain technology can help manage the supply network complexity and draw on ambidexterity theory to deal with positive and negative aspects of supply network complexity, which may help to solve marketing issues that the marketing issues are related to the supply chain management, the higher the level of supply chain management is, the more beneficial it is to the marketing of firms.

7. Implications and Directions for Future Research

7.1. Theoretical Significance. First, we divide supply network complexity into three categories: supply base complexity, logistics base complexity, and customer base complexity, supply base complexity refers to the number of suppliers, degree of difference among providers, and interrelationships among suppliers. Customer base complexity is usually dependent on the number of customers and product categories, whereas logistics base complexity relates to a supply network with a large number of carriers, where carriers indicate the network's connectivity condition; second, we use the valence framework theory to synthesize the dual characteristics of supply network complexity into positive and negative valences, to widen the applicability of the valence theory. The two sides of how to deal with the complexity of the supply network are investigated from the standpoint of exploitation and exploration, which enriches the research on the complexity of the supply network based on the ambidexterity theory.

Third, we synthesize the dual characteristics of supply network complexity into positive and negative valences and expand the application of the valence theory using the valence framework theory. These two sides of how to cope with supply network complexity are explored from the standpoints of exploitation and exploration, which contributes to the complexity of supply network research. This is one of the few studies that will use blockchain technology to do exploration and exploitation activities to deal with positive valence and negative valence of supply network complexity based on ambidexterity theory. This study also expands the application scenarios of ambidexterity theory and valence theory.

7.2. Practical Significance. This is the first study to propose the use of blockchain technology to manage supply network complexity, and it can provide some guidance for firms exploring blockchain implementation. By introducing blockchain technology into the supply chain, the supply chain's transparency might be greatly improved. Most notably, the most significant advantage of blockchain technology beyond other technologies is the achievement of trusted transparency of information on the supply chain. This study divides supply network complexity into supply base complexity, logistics base complexity, and customer base complexity, which can help managers better manage supply network complexity, and it divides the effects of supply chain network complexity into positive and negative valences, reconciling the previous study of supply network complexity into a single negative or positive study. It can give managers some direction on how to manage the supply network's complexity.

7.3. Limitations and Future Research Directions. This study also has some limitations. First, the hypothesis in this study has yet to be empirically validated, and further research will be required to demonstrate the validity of this research methodology using data. Second, there are several methods for classifying supply network complexity. In some studies, supply network complexity is classified as detail complexity and dynamic complexity, whereas in others, it is classified as upstream complexity, downstream complexity, and internal complexity. As a result, more innovative classification methods may be developed in the future. Finally, supply network complexity management can be combined with other emerging technologies in the future to demonstrate how new technologies can be utilized to regulate supply network complexity.

In conclusion, this paper contributes to the field of supply network complexity research by investigating the relationship between blockchain technology and supply network complexity, as well as presenting a new research perspective for supply network complexity management based on valence theory and ambidexterity theory.

Data Availability

The data used to support the study are included in the paper.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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References

[1] Z. Yu, A. Razzaq, A. Rehman, A. Shah, K. Jameel, and R. S. Mor, "Disruption in global supply chain and socio-economic shocks: a lesson from COVID-19 for sustainable production and consumption," *Operations Management Research*, pp. 1–16, 2021.

[2] G. M. Magableh, "Supply chains and the COVID-19 pandemic: a comprehensive framework," *European Management Review*, vol. 18, no. 3, pp. 363–382, 2021.

[3] M. A. Ateş, R. Suurmond, D. Luzzini, and D. Krause, "Order from chaos: a meta-analysis of supply chain complexity and firm performance," *Journal of Supply Chain Management*, vol. 58, no. 1, pp. 3–30, 2021.

[4] X. Zhao, K. M. Ismail, and K. M. Carley, "Organizational design and restructuring in response to crises: lessons from computational modeling and real-world cases," *Organization Science*, vol. 17, no. 5, pp. 598–618, 2006.

[5] C. Perrow, *Normal Accidents*, Princeton university press, Princeton, NJ, U.S.A, 2011.

[6] C. Perrow, "Normal accidents. Living with high-risk technologies," *Normale Katastrophen. Die unvermeidbaren Risiken der Grosstechnik*, vol. 102800, 1988.

[7] Y. Kayikci, D. Durak Usar, and B. L. Aylak, "Using blockchain technology to drive operational excellence in perishable food supply chains during outbreaks," *International Journal of Logistics Management*, 2021.

[8] D. M. Lambert and M. G. Enz, "Issues in supply chain management: progress and potential," *Industrial Marketing Management*, vol. 62, pp. 1–16, 2017.

[9] Y. Chen, S. Ding, Z. Xu, H. Zheng, and S. Yang, "Blockchain-based medical records secure storage and medical service framework," *Journal of Medical Systems*, vol. 43, no. 1, pp. 5–9, 2019.

[10] K. R. Lakhani and M. Iansiti, "The truth about blockchain," *Harvard Business Review*, vol. 95, no. 1, pp. 119–127, 2017.

[11] U. Ramanathan and A. Gunasekaran, "Supply chain collaboration: impact of success in long-term partnerships," *International Journal of Production Economics*, vol. 147, pp. 252–259, 2014.

[12] Q. Lu, M. Goh, and R. De Souza, "An empirical investigation of swift trust in humanitarian logistics operations," *The Palgrave Handbook of Humanitarian Logistics and Supply Chain Management*, vol. 8, pp. 279–296, 2018.

[13] Y. Xiong, H. K. S. Lam, A. Kumar, E. W. T. Ngai, C. Xiu, and X. Wang, "The mitigating role of blockchain-enabled supply chains during the COVID-19 pandemic," *International Journal of Operations & Production Management*, vol. 41, no. 9, pp. 1495–1521, 2021.

[14] P. Xu, J. Lee, J. R. Barth, and R. G. Richey, "Blockchain as supply chain technology: considering transparency and security," *International Journal of Physical Distribution & Logistics Management*, vol. 51, no. 3, pp. 305–324, 2021.

[15] A. Sheel and V. Nath, "Effect of blockchain technology adoption on supply chain adaptability, agility, alignment and performance," *Management Research Review*, vol. 42, no. 12, pp. 1353–1374, 2019.

[16] Y. Cui and H. Idota, "Improving supply chain resilience with establishing A decentralized information sharing mechanism," in *Proceedings of the 5th Multidisciplinary International Social Networks Conference on - MISNC '18*, pp. 1–7, Saint-Etienne, France, June 2018.

[17] M. Vivaldini and P. R. de Sousa, "Blockchain connectivity inhibitors: weaknesses affecting supply chain interaction and resilience," *Benchmarking: An International Journal*, vol. 28, no. 10, pp. 3102–3136, 2021.

[18] M. Alazab, S. Alhyari, A. Awajan, and A. B. Abdallah, "Blockchain technology in supply chain management: an empirical study of the factors affecting user adoption/acceptance," *Cluster Computing*, vol. 24, no. 1, pp. 83–101, 2020.

[19] A. Kumar, R. Liu, and Z. Shan, "Is blockchain a silver bullet for supply chain management? Technical challenges and research opportunities," *Decision Sciences*, vol. 51, no. 1, pp. 8–37, 2020.

[20] S. Tönnissen and F. Teuteberg, "Analysing the impact of blockchain-technology for operations and supply chain management: an explanatory model drawn from multiple case studies," *International Journal of Information Management*, vol. 52, Article ID 101953, 2020.

[21] A. Rejeb, J. G. Keogh, S. J. Simske, T. Stafford, and H. Treiblmaier, "Potentials of blockchain technologies for supply chain collaboration: a conceptual framework," *International Journal of Logistics Management*, vol. 32, no. 3, pp. 973–994, 2021.

[22] H. R. Vandchali, S. Cahoon, and S. L. Chen, "The impact of supply chain network structure on relationship management strategies: an empirical investigation of sustainability practices in retailers," *Sustainable Production and Consumption*, vol. 28, pp. 281–299, 2021.

[23] M. Nakano and K. Matsuyama, "The relationship between internal supply chain structure and operational performance: survey results from Japanese manufacturers," *Supply Chain Management: International Journal*, vol. 27, no. 4, pp. 469–484, 2021.

[24] T. Randall and K. Ulrich, "Product variety, supply chain structure, and firm performance: analysis of the U.S. Bicycle industry," *Management Science*, vol. 47, no. 12, pp. 1588–1604, 2001.

[25] M. B. C. Menezes, D. R. Hernández, and Y. T. Chen, "On the validity and practical relevance of a measure for structural complexity," *International Journal of Production Economics*, vol. 240, Article ID 108243, 2021.

[26] E. K. Anin, N. Boso, and D. Asamoah, "Moderating effect of supply chain complexity in governance mechanisms and operational performance relationship: evidence from a sub-Saharan African market," *Africa Journal of Management*, vol. 7, pp. 1–23, 2021.

[27] P. F. Skilton and J. L. Robinson, "Traceability and normal accident theory: how does supply network complexity influence the traceability of adverse events?" *Journal of Supply Chain Management*, vol. 45, no. 3, pp. 40–53, 2009.

[28] Y. Dong, K. Skowronski, S. Song, S. Venkataraman, and F. Zou, "Supply base innovation and firm financial performance," *Journal of Operations Management*, vol. 66, no. 7-8, pp. 768–796, 2020.

[29] T. Y. Choi and D. R. Krause, "The supply base and its complexity: implications for transaction costs, risks, responsiveness, and innovation," *Journal of Operations Management*, vol. 24, no. 5, pp. 637–652, 2005.

[30] R. Wiedmer, Z. S. Rogers, M. Polyviou, C. Mena, and S. Chae, "The dark and bright sides of complexity: a dual perspective on supply network resilience," *Journal of Business Logistics*, vol. 42, no. 3, pp. 336–359, 2021.

[31] C. C. Bozarth, D. P. Warsing, B. B. Flynn, and E. J. Flynn, "The impact of supply chain complexity on manufacturing plant performance," *Journal of Operations Management*, vol. 27, no. 1, pp. 78–93, 2009.

[32] J. P. Peter, "A comparative analysis of three consumer decision strategies," *Journal of Consumer Research*, vol. 2, no. 1, pp. 29–37, 1975.

[33] D. J. Kim, D. L. Ferrin, and H. R. Rao, "A trust-based consumer decision-making model in electronic commerce: the role of trust, perceived risk, and their antecedents," *Decision Support Systems*, vol. 44, no. 2, pp. 544–564, 2008.

[34] T. Y. Choi, S. Narayanan, D. Novak, J. Olhager, J. B. Sheu, and F. Wiengarten, "Managing extended supply chains," *Journal of Business Logistics*, vol. 42, no. 2, pp. 200–206, 2021.

[35] G. M. Hastig and M. S. Sodhi, "Blockchain for supply chain traceability: business requirements and critical success factors," *Production and Operations Management*, vol. 29, no. 4, pp. 935–954, 2020.

[36] M. Montecchi, K. Plangger, and M. Etter, "It's real, trust me! Establishing supply chain provenance using blockchain," *Business Horizons*, vol. 62, no. 3, pp. 283–293, 2019.
[37] K. S. Hald and A. Kinra, "How the blockchain enables and constrains supply chain performance," *International Journal of Physical Distribution & Logistics Management*, vol. 49, no. 4, pp. 376–397, 2019.
[38] W. Yin and W. Ran, "Theoretical exploration of supply chain viability utilizing blockchain technology," *Sustainability*, vol. 13, no. 15, p. 8231, 2021.
[39] A. K. Gupta, S. P. Raj, and D. Wilemon, "A model for studying R&D-Marketing interface in the product innovation process," *Journal of Marketing*, vol. 50, no. 2, pp. 7–17, 1986.
[40] P. Kumar, N. Langberg, and D. Zvilichovsky, "Crowdfunding, financing constraints, and real effects," *Management Science*, vol. 66, no. 8, pp. 3561–3580, 2020.
[41] H. Treiblmaier, "The impact of the blockchain on the supply chain: a theory-based research framework and a call for action," *Supply Chain Management: International Journal*, vol. 23, no. 6, pp. 545–559, 2018.
[42] E. Brynjolfsson and A. McAfee, *The Second Machine Age: Work, Progress, and prosperity in a Time of Brilliant Technologies*, WW Norton & Company, New York, NY, USA, 2014.
[43] C. Bode and S. M. Wagner, "Structural drivers of upstream supply chain complexity and the frequency of supply chain disruptions," *Journal of Operations Management*, vol. 36, no. 1, pp. 215–228, 2015.
[44] G. Y. Gao, E. Xie, and K. Z. Zhou, "How does technological diversity in supplier network drive buyer innovation? Relational process and contingencies," *Journal of Operations Management*, vol. 36, no. 1, pp. 165–177, 2015.
[45] I. Giannoccaro, A. Nair, and T. Choi, "The impact of control and complexity on supply network performance: an empirically informed investigation using NK simulation analysis," *Decision Sciences*, vol. 49, no. 4, pp. 625–659, 2018.
[46] G. Lu and G. Shang, "Impact of supply base structural complexity on financial performance: roles of visible and not-so-visible characteristics," *Journal of Operations Management*, vol. 53-56, no. 1, pp. 23–44, 2017.
[47] M. A. Bellamy, S. Ghosh, and M. Hora, "The influence of supply network structure on firm innovation," *Journal of Operations Management*, vol. 32, no. 6, pp. 357–373, 2014.
[48] J. Aitken, C. Bozarth, and W. Garn, "To eliminate or absorb supply chain complexity: a conceptual model and case study," *Supply Chain Management: International Journal*, vol. 21, no. 6, pp. 759–774, 2016.
[49] M. Chen, H. Liu, S. Wei, and J. Gu, "Top managers' managerial ties, supply chain integration, and firm performance in China: a social capital perspective," *Industrial Marketing Management*, vol. 74, pp. 205–214, 2018.
[50] H. Lorentz, J. Töyli, T. Solakivi, H. M. Hälinen, and L. Ojala, "Effects of geographic dispersion on intra-firm supply chain performance," *Supply Chain Management: International Journal*, vol. 17, no. 6, pp. 611–626, 2012.
[51] R. Rossiter and A. M. Knemeyer, "Controlling for logistics complexity: scale development and validation," *International Journal of Logistics Management*, vol. 20, no. 2, pp. 187–200, 2009.
[52] C. Bode and J. R. Macdonald, "Stages of supply chain disruption response: direct, constraining, and mediating factors for impact mitigation," *Decision Sciences*, vol. 48, no. 5, pp. 836–874, 2017.
[53] H. Yu, A. Z. Zeng, and L. Zhao, "Single or dual sourcing: decision-making in the presence of supply chain disruption risks," *Omega*, vol. 37, no. 4, pp. 788–800, 2009.
[54] C. S. Tang, "Robust strategies for mitigating supply chain disruptions," *International Journal of Logistics Research and Applications*, vol. 9, no. 1, pp. 33–45, 2006.
[55] Y. Park, P. Hong, and J. J. Roh, "Supply chain lessons from the catastrophic natural disaster in Japan," *Business Horizons*, vol. 56, no. 1, pp. 75–85, 2013.
[56] T. Xiao and X. Qi, "Price competition, cost and demand disruptions and coordination of a supply chain with one manufacturer and two competing retailers," *Omega*, vol. 36, no. 5, pp. 741–753, 2008.
[57] A. Arshinder, A. Kanda, and S. G. Deshmukh, "Supply chain coordination: perspectives, empirical studies and research directions," *International Journal of Production Economics*, vol. 115, no. 2, pp. 316–335, 2008.
[58] J. Olhager, "The role of the customer order decoupling point in production and supply chain management," *Computers in Industry*, vol. 61, no. 9, pp. 863–868, 2010.
[59] M. Montecchi, K. Plangger, and D. C. West, "Supply chain transparency: a bibliometric review and research agenda," *International Journal of Production Economics*, vol. 238, Article ID 108152, 2021.
[60] N. Kumar and A. Yakhlef, "Managing business-to-business relationships under conditions of employee attrition: a transparency approach," *Industrial Marketing Management*, vol. 56, pp. 143–155, 2016.
[61] T. Hammervoll and E. Bø, "Shipper-carrier integration," *European Journal of Marketing*, vol. 44, no. 7/8, pp. 1121–1139, 2010.
[62] K. Bailey and M. Francis, "Managing information flows for improved value chain performance," *International Journal of Production Economics*, vol. 111, no. 1, pp. 2–12, 2008.
[63] E. Brandon-Jones, B. Squire, C. W. Autry, and K. J. Petersen, "A contingent resource-based perspective of supply chain resilience and robustness," *Journal of Supply Chain Management*, vol. 50, no. 3, pp. 55–73, 2014.
[64] N. Osadchiy, V. Gaur, and S. Seshadri, "Systematic risk in supply chain networks," *Management Science*, vol. 62, no. 6, pp. 1755–1777, 2016.
[65] M. S. Sodhi and C. S. Tang, "Research opportunities in supply chain transparency," *Production and Operations Management*, vol. 28, no. 12, pp. 2946–2959, 2019.
[66] B. Kalkanci and E. L. Plambeck, "Managing supplier social and environmental impacts with voluntary versus mandatory disclosure to investors," *Management Science*, vol. 66, no. 8, pp. 3311–3328, 2020.
[67] Y. H. Kim and G. F. Davis, "Challenges for global supply chain sustainability: evidence from conflict minerals reports," *Academy of Management Journal*, vol. 59, no. 6, pp. 1896–1916, 2016.
[68] A. Ghosh and J. Fedorowicz, "The role of trust in supply chain governance," *Business Process Management Journal*, vol. 14, no. 4, pp. 453–470, 2008.
[69] L. Koh, A. Dolgui, and J. Sarkis, "Blockchain in Transport and Logistics–Paradigms and Transitions," *International Journal of Production Research*, vol. 58, no. 7, pp. 2054–2062, 2020.
[70] D. Tapscott and A. Tapscott, "How blockchain will change organizations," *MIT Sloan Management Review*, vol. 58, no. 2, p. 10, 2017.
[71] P. P. Datta and M. G. Christopher, "Information sharing and coordination mechanisms for managing uncertainty in supply

chains: a simulation study," *International Journal of Production Research*, vol. 49, no. 3, pp. 765–803, 2011.

[72] S. Maheshwari, P. Gautam, and C. K. Jaggi, "Role of big data analytics in supply chain management: current trends and future perspectives," *International Journal of Production Research*, vol. 59, no. 6, pp. 1875–1900, 2021.

[73] V. K. Manupati, T. Schoenherr, M. Ramkumar, S. M. Wagner, S. K. Pabba, and R. Inder Raj Singh, "A blockchain-based approach for a multi-echelon sustainable supply chain," *International Journal of Production Research*, vol. 58, no. 7, pp. 2222–2241, 2020.

[74] D. Macrinici, C. Cartofeanu, and S. Gao, "Smart contract applications within blockchain technology: a systematic mapping study," *Telematics and Informatics*, vol. 35, no. 8, pp. 2337–2354, 2018.

[75] A. Dolgui, D. Ivanov, S. Potryasaev, B. Sokolov, M. Ivanova, and F. Werner, "Blockchain-oriented dynamic modelling of smart contract design and execution in the supply chain," *International Journal of Production Research*, vol. 58, no. 7, pp. 2184–2199, 2020.

[76] Z. A. Collier and J. Sarkis, "The zero trust supply chain: managing supply chain risk in the absence of trust," *International Journal of Production Research*, vol. 59, no. 11, pp. 3430–3445, 2021.

[77] L. W. Wong, G. W. H. Tan, V. H. Lee, K. B. Ooi, and A. Sohal, "Unearthing the determinants of Blockchain adoption in supply chain management," *International Journal of Production Research*, vol. 58, no. 7, pp. 2100–2123, 2020.

[78] X. Xu, M. Zhang, G. Dou, and Y. Yu, "Coordination of a supply chain with an online platform considering green technology in the blockchain era," *International Journal of Production Research*, pp. 1–18, 2021.

[79] Y. Chang, E. Iakovou, and W. Shi, "Blockchain in global supply chains and cross border trade: a critical synthesis of the state-of-the-art, challenges and opportunities," *International Journal of Production Research*, vol. 58, no. 7, pp. 2082–2099, 2020.

[80] P. Helo and A. H. M. Shamsuzzoha, "Real-time supply chain-A blockchain architecture for project deliveries," *Robotics and Computer-Integrated Manufacturing*, vol. 63, Article ID 101909, 2020.

[81] Y. Wang, C. H. Chen, and A. Z. Sales, "Designing a blockchain enabled supply chain," *International Journal of Production Research*, vol. 59, no. 5, pp. 1450–1475, 2021.

[82] K. Wust and A. Gervais, "Do you need a blockchain?" in *Proceedings of the 2018 Crypto Valley Conference on Blockchain Technology (CVCBT)*, Zug, Switzerland, June 2018.

[83] H. Maylor and N. Turner, "Understand, reduce, respond: project complexity management theory and practice," *International Journal of Operations & Production Management*, vol. 37, no. 8, pp. 1076–1093, 2017.

[84] J. G. March, "Exploration and exploitation in organizational learning," *Organization Science*, vol. 2, no. 1, pp. 71–87, 1991.

[85] R. A. Eltantawy, "The role of supply management resilience in attaining ambidexterity: a dynamic capabilities approach," *Journal of Business & Industrial Marketing*, vol. 31, no. 1, pp. 123–134, 2016.

[86] C. Blome, T. Schoenherr, and D. Rexhausen, "Antecedents and enablers of supply chain agility and its effect on performance: a dynamic capabilities perspective," *International Journal of Production Research*, vol. 51, no. 4, pp. 1295–1318, 2013.

[87] R. C. Lamming, N. D. Caldwell, D. A. Harrison, and W. Phillips, "Transparency in supply relationships: concept and practice," *Journal of Supply Chain Management*, vol. 37, no. 3, pp. 4–10, 2001.