Innovation adoption of blockchain technology in

supply chain finance

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**Abstract**: This paper presents a multiple case study analysis on how blockchain technology (BCT) has been adopted in organizations to support supply chain finance (SCF) based on secondary data. Findings from the multiple case analysis indicate that BCT can cope with challenges in traditional SCF, including financing range, financing cost, financing efficiency, and risk management. Before the implementation of the BCT, multiple parties’ decision on jointly operating the blockchain-based SCF platform enables them to take full advantage of their inherent resources and blockchain characteristics. Also, both the BCT and enterprises need internal and external adjustments, which are interrelated. The unexpected issues may emerge from the pilot stage, but the adjustments are still involved in the previous stages, leading to a feedback loop from the pilot stage to the redefining/restructuring stage. To realize large-scale implementation of blockchain-based SCF solutions, more stakeholders need to be motivated to adopt the BCT, and new laws and regulations should be developed to promote the BCT adoption. Based on these findings and by applying innovation adoption theory, an overall implementation framework is proposed to provide a meaningful guidance for organizations to adopt BCT in SCF.

**Keywords:** blockchain technology; supply chain finance; innovation adoption theory; case study

# 1. Introduction

Liquidity shortage has always been a problem that plagues enterprises, which also affects the performance of entire supply chains (Caniato et al. 2016). The context of this problem promotes the development of solutions for inter-organizational financial flow management (Moretto et al. 2019). Among these, one of the most influential instruments is supply chain finance (SCF), which aims to optimise financial flows from an organizational perspective by implementing supply chain solutions provided by financial institutions, logistics service providers, and technology providers (Hofmann 2005). The final objective of SCF is to integrate business flow, physical flow, information flow, and financial flow, the four flows among multiple parties within the supply chain and to improve cash-flow management at the supply chain network level (Wuttke et al. 2013; Gelsomino et al. 2016).

As the second-largest economy, the bottlenecks of SCF are particularly pronounced in China. The expanding market size and emergence of the multi-participant structure are driving the transformation of SCF in China. In addition, policy support, e.g. financing structure reformation, real economy services, and small- and medium-sized enterprises (SMEs) financing support, is gradually reconciling the emerging market. However, considering the preliminary stage of the SCF market in China, there are still challenges that continue to be addressed (Wang et al. 2020a).

McKinsey (2021) notes the urgency of improving the $5.2 trillion global trade finance ecosystem to facilitate the flow of global goods and services, while the Chinese market demand of SCF for accounts receivable financing exceeds 28.6 trillion yuan (AskCI 2021). However, the actual loaning of funds is only about one trillion yuan, which results from the challenges in traditional SCF businesses. There are several reasons for this discrepancy. The credit of focal enterprises can only be passed to a first-tier supplier, and lower-tier suppliers find it difficult to obtain loans due to lack of credit, because they do not possess accounts receivable bills issued by focal firms (Wang et al. 2020a). This situation gives rise to a challenge in financing for small- and medium-sized enterprises (SMEs) at lower tiers. Furthermore, the root cause is that the current bills have reduced liquidity and cannot be split. Therefore, accounts receivable bills can only be transferred between focal enterprises and first-tier suppliers (Xu et al. 2018). Also, the inherent complexities in SCF processes lead to a lack of transparency and trust among stakeholders, which impedes the dissemination of SCF.

A recent case reflects widespread concern in the Chinese SCF industry. Noah Holdings Ltd., one of China’s most prominent wealth management companies, sued the founder of Chinese conglomerate Camsing Global for 4.2 billion yuan ($610 million) for losses related to a newly exposed fundraising scandal. The lawsuit named Lo Ching, the chairwoman of Camsing Global, as the defendant. Lo had been utilizing several companies as financing platforms, raising funds through issuing financial products backed by accounts receivable from JD.com, China Mobile, and Suning.com, involving billions of yuan (Liang et al. 2019). However, JD.com denied involvement in the fundraising and accused Camsing of falsifying business contracts of the accounts receivable, although it admitted to Camsing being a JD.com supplier. Moreover, similar disputes arose in business dealings with China Mobile and Suning.com. The part of the specific businesses committing fraud remains to be investigated at the time of writing this paper, but the matter has sounded the alarm for the industry.

Indeed, how to improve the authenticity of the four flows in the supply chain has become a pressing concern for financial institutions. Multi-party verification seems to be a positive solution. However, there is still no unified business information system among enterprises. The supply chain management system, enterprise resource management system (ERP), and financial system used by each entity are different, leading to a challenge in information integration (Wei and Jia 2019).

Newly emerging blockchain technology (BCT), characterized by decentralization, traceability, immutability, and smart contracts, seems to be notably suitable for dealing with these problems, enhancing the collaboration of multiple parties in SCF, and improving the integration of the four flows (Hastig and Sodhi 2020; Papadopoulos et al. 2021). It is also suggested that the processes of traditional SCF could strongly benefit from blockchain-based solutions, given these advanced features (Hofmann et al. 2017). Research also suggests that a multi-party joint operation model may be suitable for the adoption of BCT in SCF (Queiroz et al. 2021). The launcher could be a technology service provider, focal enterprise, or financial institution. The adoption of BCT by enterprises will not only improve supply chain performance but also benefit them in meeting SCF objectives. However, the BCT has not been widely adopted by enterprises to support SCF businesses, which is crucial and requires attention (Li et al. 2020). In fact, the BCT adoption is not an easy task, which could be impeded from four barrier categories, including behavioural, organisational, technological, and policy-oriented aspects (Saberi et al. 2019). Without the facilitating conditions of supply chain collaboration and resource orchestration, the BCT adoption in SCF businesses tend to fail (Queiroz et al. 2021). Also, a high failure rate is fair given the early state of play for blockchain in the digital transformation arsenal. The high failure rate, which some estimate as high 92%, indicates the broader complexity for technology-powered change (Disparte 2019). Therefore, it deserves scholarly attention to explore both the advantages and the adoption issues of BCT-based SCF businesses. Primarily, we focus on two research questions:

* How can BCT overcome SCF challenges?
* How can enterprises manage the BCT adoption process to support SCF businesses effectively?

In order to answer these questions, this study employs the multiple case study methodology to conduct an exploratory research, which is meaningful to uncover multiple facets of the BCT adoption in the context of SCF based on publicly documented cases. By addressing the research questions, this study makes several contributions to theory and practice. First, it determines four dimensions from which BCT can cope with challenges in traditional SCF, including financing range, financing cost, financing efficiency, and risk management. Second, it provides in-depth implications from both internal and external perspectives on the enterprises’ adjustments when they decide to adopt the BCT to support SCF businesses. Also, the implications on the BCT’s adjustments and its interrelationships with enterprises are provided. Third, it utilizes Rogers’ (2003) innovation adoption framework to structure the findings about advantages and adoption coordination of BCT-based SCF solutions, which sheds light on organizations’ adoption management of BCT in SCF businesses. Finally, it provides an empirical contribution to the emerging field of research on BCT applications in SCF (Chod et al. 2020; Chod et al. 2022; Yu et al. 2021).

The remainder of this paper is structured as follows. Section 2 provides a literature review of challenges in SCF, BCT, and innovation adoption within organizations; Section 3 presents the exploratory research methodology, followed by the findings of multiple case analysis in Section 4; Section 5 utilizes the innovation adoption framework to structure the findings against the literature and offers a conceptual framework with several propositions; Section 6 discusses how the findings shape the proposed framework. Finally, Section 7 summarizes theoretical and practical contributions, also stating limitations and future research directions.

# 2. Literature Review

The literature review can be divided into three parts. The first describes the challenges faced by the traditional SCF activities; the second presents the preliminary exploration into the emerging field of the BCT in SCF applications; the third details the innovation adoption process in organizations to extract the research focus in this paper.

## 2.1 Challenges in SCF

Economic globalization leads to fierce competition and a higher level of risk in supply chains, because of which many enterprises are facing complex situations and multiple uncertainties in their businesses (Manuj and Mentzer 2008). On the one hand, such uncertainties resulted from task characteristics, task environment, and task interdependence of SCF mean increased information processing requirements from SCF providers in managing supply chain processes and the four flows (Jia et al. 2020); on the other hand, a prerequisite for financial institutions providing financing services to enterprises is to have capabilities to obtain and process sufficient information on the whole business, which is still hard to achieve because information sharing is negatively affected by supplier uncertainty (Li and Lin 2006). Consequently, the mismatch between information processing requirements and capabilities leads to high costs and inefficiency in SCF, and even hurts supply chain performances (Jia et al. 2020; Wong et al. 2015).

SCF is more beneficial for the involved partners that are highly integrated and coordinated within shared financial information systems (Blackman et al. 2013; Pfohl and Gomm 2009). However, financial information cannot be fully shared in the traditional SCF. For example, as one of the instruments in SCF, reverse factoring is used frequently in financial services. As an initiator of reverse factoring, a buyer must onboard its suppliers one by one in the onboarding phase, which is time-consuming (Omran et al. 2017). Also, since different SCF platforms are essentially information silos, they are unlikely to share relevant data about customers for the sake of information disclosure. Therefore, the buyer may need to repeat the onboarding process when conducting reverse factoring of different financing platforms, which is a waste of resources and lower the efficiency of the entire supply chain (Hofmann et al. 2017).

Another factor that has hindered the adoption of SCF is that SMEs have limited access to such practices. It is difficult for many SMEs to apply for financial services from conservative financial institutions and banks given their scant credit history and limited fixed assets (Wang et al. 2020b). As for focal enterprises, optimizing cash-to-cash cycle is one of their goals, which means that they need to reduce inventories and accounts receivable and extend accounts payable (Randall and Farris 2009). However, this will exacerbate liquidity shortage of SMEs who are limited in size, working capitals, and credit levels. Although first-tier SME suppliers may obtain loans from banks and other types of lenders through the endorsement of focal enterprises, these suppliers account for only a small proportion of SMEs (Wilhelm et al. 2016). Consequently, the traditional SCF can only radiate throughout a small number of enterprises; an extensive range of the SCF market has not been explored.

Traditional SCF is an isolated component used by enterprises in the supply chain to optimise working capital and financial flows (Omran et al. 2017). One of SCF applications, asset-backed securitization (ABS), can be used to finance all types of assets with stable cash flows, such as consumer credits, supplier-led account receivables, buyer-led approved payables, and inventory assets, which not only concern corporate finance but are highly relevant with production planners and supply chain managers (Chen et al. 2022; Hofmann et al. 2017). However, multiple parties and complex processes involved in the ABS have led to the primary risk for enterprises of managing working capital effectively. Central to SCF businesses, the technology platform is indispensable to share information and simplify processes. Specifically, the platform facilitates focal enterprises to transact with their suppliers and enables SCF providers to obtain transactional information on supply chain partners (Wuttke et al. 2019). However, current information technologies and paper-based invoices put SCF providers at risks of financial frauds, such as fraudulent invoicing and deliberate defaults (Hofmann et al. 2017). Process complexity and intermediaries in SCF further leads to greater regulation risk and higher costs. Therefore, appropriate adjustment mechanisms and potential innovative solutions are urgently needed.

## 2.2 Blockchain technology as a disruptive innovation in SCF

One emerging technology, blockchain technology is considered a potentially innovative tool to solve existing problems. Blockchain is a distributed ledger, which contains cryptographic algorithms, smart contracts, and consensus mechanisms (Zheng et al. 2017), and it can achieve a few valuable characteristics, such as traceability, immutability, decentralization, smart contracts, and process integrity (Abeyratne and Monfared 2016; Moradlou et al. 2020).Because of the superior characteristics and peer-to-peer network structure, BCT is feasibly a disruptive innovation facilitating SCF with novel solutions, including blockchain-based reverse factoring, inventory financing, and asset-backed securitization (ABS) (Hofmann et al. 2017). BCT also enables leveraging the highest potential of SCF, for instance, allowing a large number of upstream suppliers to participate in reverse factoring and obtain financing services (Caniato et al. 2019; Zheng et al. 2020).

Integrated within BCT, smart contracts, as proposed by Szabo (1994), have become an important characteristic. Digitized into codes, the contract protocols are incorporated into the blockchain and executed automatically when transactions match the predefined protocols (Vu et al. 2021). These smart contracts can be utilized to improve the efficiency of SCF by automating financial transactions (Omran et al. 2017). Moreover, the internet of things (IoT) technology is also suitable for integration with BCT to provide possible solutions for SCF (Lahkani et al. 2020). For instance, IoT sensors are capable of obtaining the position and status data of physical flow along the supply chain, and BCT can record and share information collected by IoT, which improves the transparency of the entire chain (Li et al. 2020; Sony and Naik 2020).

Business models in SCF involve multiple parties. With the support of BCT, the integration of information flows, physical flows, and financial flows is enhanced and information transparency is improved, which facilitates trust-building among stakeholders (Chod et al. 2020). In practice, if not properly implemented and managed, innovation and improved processes may not deliver better financial performance (Yu et al. 2019). Although the application prospects of BCT are broad and the BCT is expected to leverage the SCF potential, its scholarly research, especially into the innovation adoption process of BCT in SCF, is still in its infancy (Bogucharskov et al. 2018; Chod et al. 2020). Without the deep exploration on this problem, we still know little about how to utilize the BCT to support SCF businesses effectively.

In practice, these functions vary across blockchain types and in practical situations. In general, BCT can be classified as permissioned and permissionless version, and some proposed public, private, consortium and hybrid types (Queiroz et al. 2021). For example, based on the difference in access and decision-making rights, private chains require that only trusted members join, which may mitigate the principle of decentralization. From the perspective of incentive, the effective application of the BCT in SCF businesses requires the participation of the focal company as well as upstream and downstream stakeholders, which is affected differently by the type of the BCT (Chod et al., 2020). The motivations for supply chain members to participate in blockchain-based SCF solutions are related to the allocation of stakeholder responsibilities and the division of benefits, as application of the BCT requires information sharing and incurs non-trivial costs. Considering the potential barriers and failures of the BCT adoption, it is critical to further explore how to balance the adoption challenges of the BCT in SCF.

## 2.3 Innovation adoption process in organizations

Innovation adoption theory – or innovation diffusion theory – was not widely received or acknowledged by academics until Rogers (2003) introduced the diffusion of innovations theory, proposing two categories of innovation adoption process, by individuals and organizations, respectively. The latter arouses much academic attention and also inspires us to focus on the detailed adoption process of the BCT in SCF in this study.

The innovation process in organizations consists of five stages, namely agenda-setting, matching, redefining/restructuring, clarifying, and routinizing (Rogers 2003), which are presented in Figure 1. These five stages can also be divided into two subprocesses, initiation and implementation. In the initiation subprocess, all the related information needs to be gathered to make a plan for adopting an innovation. The challenges of implementing SCF solutions in organizations and gaining knowledge about blockchain functions can occur in this process. Whether the problems in organizations match the innovation determines whether they decide to adopt it. Factors affecting the BCT adoption, such as knowledge, organizational culture, supply chain collaborations, in organisations may also need to be considered, owing to the prevalent challenges and barriers of this disruptive innovation adoption (Janssen et al. 2020; Saberi et al. 2019; Wamba and Queiroz 2020).

The implementation subprocess focuses on all the actions related to physically deploying the innovation. Mutual adaptation is a necessary adjustment, in which both the innovation and the organization have to alter to some extent. The success of innovation adoption in organizations cannot be guaranteed by merely possessing valuable resources, unless they are managed effectively (Sirmon et al. 2011). As facilitating conditions is one of the most critical constructs that have a positive impact on BCT adoption (Queiroz et al. 2021), during the innovation adoption process of the BCT in SCF, organizations may need to orchestrate resources (Gong et al. 2018) and alter the original supply chain financial network, creating suitable innovation adoption conditions(Wuttke et al. 2019). The functions of the original stakeholders in SCF may mitigate or disappear and be combined with the blockchain-based network, which leads to the occurrence of disintermediation or reintermediation (Tönnissen and Teuteberg 2020). Furthermore, such efforts may need to be spent on overcoming barriers moving from the pilot stage to the large-scale implementation stage (van Hoek 2019).

Analyzing organizational innovation adoption through such a framework has inherent advantages because it emphasizes the implementation stage in deploying innovations. Specifically, the innovation adoption framework provides a clear picture of the process of applying technology at different stages. As an emerging technology, BCT is a potentially disruptive solution for the SCF scenario. The current exploration of BCT in the SCF is at an initial stage and it is necessary to examine the preconditions for innovation adoption and the future scale-up process. It explains theoretically the mechanism of BCT application and the dynamic process of innovation in the industry. By applying with real case studies, this theoretical lens can offer a more practical application logic and process reference for industry managers, which may contribute to the scale-up decision making.

Similar to Wuttke et al. (2013), we base on the Rogers framework to structure our multiple case analysis. However, we focused more on technology rather than inter-departmental cooperation and explored how SCF-related enterprises manage BCT adoption process to support SCF businesses effectively.

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# 3. Research Methodology

The methodology of this paper can be summarized as an exploratory multiple case study, one of the most convincing research methods in operations management (Voss er al. 2002; Barratt et al. 2011).

In this study, we aim to explore relevant advantages and hinders of the BCT adoption in the context of SCF to answer the research questions. The motivation of this research mainly comes from two aspects. On the one hand, challenges in the traditional SCF hinder the development of SCF businesses, leading us to explore how to utilize the BCT to overcome the challenges and support SCF businesses. On the other hand, several aspects need to be considered when enterprises decide to adopt the BCT in SCF, including organizational coordination and resource orchestration. Therefore, we follow the rigorous processes suggested in the operations management literature to conduct an exploratory case research, which is meaningful to uncover multiple facets of the BCT adoption in the context of SCF based on publicly documented cases. ( Edmondson and McManus 2007; Ketokivi and Choi 2014; Pagell and Wu 2009; Stuart et al. 2002).

## 3.1 Research design

As the objective of this research is related to the “how” questions, we select the multiple case study method to solve the exploratory problem, which enables us to focus on the multiple facets of the BCT adoption in SCF businesses. Compared to the single case study, the multiple case study tends to be more reliable in theory development by augmenting external validity (Rowley 2002; Choi et al. 2016; Hu et al. 2016). Such method provides better insights into real phenomena and contributes to rich experience descriptions and exploratory investigation (Yin 2009). In other words, it helps to fill the gap in existing theory that does not adequately explain the phenomenon under investigation (Barratt et al. 2011). Yin (2009) pointed out that exploratory cases studies are suitable for identifying specific practices and operationalizing the actual organisational changes that mark a routinization process. Based on the innovation adoption theory and the emergent BCT applications in SCF, multiple case study provides a good fit to relate existing practices with literature. Specifically, theoretical framework is adopted to better structure findings in light of contemporary phenomenon (Voss et al. 2002; Ketokivi and Choi 2014), i.e. BCT adoption in SCF applications.

## 3.2 Selection of cases

In case research, if we decide to conduct rigorous case studies, a sample of cases should be constructed by selecting cases according to different criteria (Yin 2009). The goals of case selection in multiple case study research are to represent the wider population of cases and to present a meaningful variation on the dimensions of note (Voss et al. . Compared to random sampling, a critical distinction exists in the selection standard for identifying suitable cases in multiple case study research; it should be based on substance rather than statistics (Greene and David 1984).

This study follows rigorous case selection procedures with motivation, inspiration, and illustration purposes proposed by Siggelkow (2007) and Gibbert et al. (2008). The focus of analysis for selected cases is BCT based SCF businesses. Based on existing literature and discussions with industry experts, we conceptualised the initial criteria of case selections as follows. The first criterion is that selected cases must have implemented BCT in real SCF activities with complete business models. Some enterprises may have proposed the vision of blockchain-based SCF solutions but have not taken further actions. Second, cases that involve multiple stakeholders are selected as the emerging interactions among multiple stakeholders can better reflect the impacts of blockchain characteristics. Third, different blockchain characteristics need to be taken advantage of to deal with several challenges in traditional SCF solutions, which drive organizations to adjust the innovation adoption process of the BCT in SCF. Finally, selected cases must have sufficient and accessible information to answer research questions and support case analysis.

From the contextual background perspective, we narrowed the focus to the Chinese market due to the promising trend of SCF transformation and the high priority of BCT application of national strategies in China. Also, China is also seen as one of the leaders in BCT applications (Wang et al. 2020a), and the focus on the Chinese SCF market can capture state-of-art trends in BCT applications. Based on the above selection criteria, we search with keywords “blockchain platform” and “blockchain and supply chain finance” in Baidu pages, and we screened representative cases from the first 50 pages of search results, which reflect the emergence of this trend and is sufficiently influential. In the beginning stage, we find twenty targeted organizations that have strong interests in employing BCT in SCF applications. Then, we conduct advanced searching by enterprises’ official websites, prominent newspapers, professional magazines, and business wire news to gain detailed information. We find that two cases just proposed the vision of using BCT in SCF businesses without practical applications. Also, eight cases are BCT providers that just offer technical solutions without involving SCF business model. Furthermore, we exclude cases with limited supporting evidence from third parties. Finally, we identify five qualified cases in this study.

## 3.3 Data collection and analysis

To ensure the effectiveness of the multiple case research, the data quality of selected cases should be addressed during the data collection process. Various dimensions related to data quality have been identified in the previous literature, which are important for creating reliable results (Golder 2000; Eisenhardt and Graebner 2007).

This research follows rigorous data collection based on secondary data. Eisenhardt and Graebner (2007) considered that secondary data can fit into the analysis process of the case study, which can achieve the methodological fit and internal consistency (Edmondson and McManus 2007). Also, adequate data sources enable richer exploration of case phenomena and such secondary data sources can reduce subjective bias, in particular, objectively reflect the potential challenges of BCT application. As early research, secondary data provides a timely and accurate picture of real-time trends within the industry (Calantone and Vickery 2010). Similarly, some seminal studies of BCT and supply chains based on secondary data sources provide insightful implications (Kshetri, 2018; Hastig and Sodhi, 2020; Nandi et al., 2020).

To achieve the trustworthiness and reputation of data quality, this research employs multiple authoritative third-party sources, visiting websites of enterprises with BCT-enabled SCF solutions and largely referring to reports published by reputable third parties, to mitigate potential bias from self-reporting (Wang and Strong 1996; Calantone and Vickery, 2010). Also, case study research is mainly based on the pattern of realistic inquiry because the main purposes are to explore new relationships in realities and to establish an understanding of the implications of experience (Hunt 1990; Riege 2003). Therefore, another dimension of data quality is the precise mapping of phenomena in the real world (Eppler 2006). To achieve this goal, we refer to the literature related to BCT and SCF to determine the detailed information of blockchain-based SCF business models. Moreover, the age of data, represented by ‘timeliness’, should also be considered in case the collected data become outdated. In this respect, we ensure that the timeliness of the collected data is suitable for studying the chosen cases, by paying attention to the most recent news on our case companies. To this end, we select five SCF cases in China and garner rich secondary data to carry out our analysis and discussion. To argument the reproducibility of data collection and analysis, the sources of data are listed in Appendix A with details of each case can be obtained from the corresponding author.

The data analysis approach in this study is based on thematic analysis, as we address the research questions by uncovering themes emerged from the data (Braun and Clarke 2006). Firstly, we integrate and code the data collected from all the data sources. To argument validity and reliability of our research, we adapt the emerged themes to relate our findings with previous research (Wuttke et al. 2013). Secondly, we conduct axial coding by categorizing codes into groups and constructing causal relationships to match common patterns among cases (Voss et al. 2002). Thirdly, we utilize those relationships which indicate meaningful insights in regard to innovation adoption of BCT in SCF for further study, challenging observations with existing research (Rogers 2003; Wuttke et al. 2013). Throughout the thematic analysis, we iterate the above steps to explore the proposed relationships with the actual data, ensuring that the higher level of extraction maintains valid empirically. The data analysis process as Figure 2 below shows.

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# 4. Findings

Based on the collected data, we find that the blockchain-based SCF platform can be launched by a BCT service provider (Tencent Cloud, Bubi, and Hyperchain), focal enterprise (Ant Financial, Suning Finance, and Tencent Cloud, belonging to Alibaba, Suning, and Tencent, respectively), or financial institution (Ant Financial and Suning Finance), to address the traditional SCF challenges. Three financing modes of the traditional SCF are discussed and extended to incorporate the support of BCT. These are blockchain-based reverse factoring (Ant financial, Bubi, Tencent cloud and Hyperchain), blockchain-based inventory financing (Suning Finance and Tencent cloud), and blockchain-based ABS (Bubi), which are summarized in Table 1.

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Furthermore, we analyze how BCT can tackle the challenges in traditional SCF from four angles, namely financing range, financing costs, financing efficiency, and risk control.

Firstly, BCT allows for a broader **financing range**, which can be illustrated from two perspectives, financing modes and access to financing. In the traditional reverse factoring, only the first-tier supplier, who have direct transactions with focal enterprises, can obtain loans from financial institutions (Wuttke et al. 2013). From the selected cases, it can be known that BCT enhances the performances of these three kinds of financing modes. Specifically, three of the cases (Ant Financial, Tencent cloud, and Hyperchain) utilize the BCT to improve the traditional business of reverse factoring. Stakeholders in the traditional reverse factoring, including focal enterprises, suppliers, and banks, need to be coordinated with each other through the blockchain platforms launched by FinTech companies or technology service providers. The blockchain platforms enable focal enterprises to issue digital invoices on chain based on accounts receivable in real transactions. Also, digital invoices can be split and circulate through the blockchain platforms, which enables the credit of focal enterprises to be transferred among the whole supply chain, because holding digital invoices is equivalent to holding the credit of focal enterprises. Thus, lower-tier SMEs holding the digital invoices issued by focal enterprises can gain access to low-cost loans and other financial services.

Suning Finance and Tencent Cloud developed a movable property pledge financing platform to improve inventory financing instruments, which facilitates third-party logistics service providers in supervising collateral through warehousing and logistics. Combined with other technologies such as IoT, AI, and BDA, information flows and physical flows can be automatically recorded on blockchain platform safely and authentically, which stimulates the release of financial flows from financial institutions by reducing their worries about the authenticity of the collateral. Similar to blockchain-based inventory financing, blockchain-based ABS business implemented by Bubi also allows for automatic supervision on underlying assets of ABS. Moreover, this solution aims at optimizing complicated manual processes and eliminating paper-based documentations in the traditional businesses, which enables financing a wider range of illiquid assets.

Furthermore, these blockchain-based platforms can provide supply chain members with other financial services, including certification, voucher management, asset management, and gross settlement, coping impressively with their challenges in financing. Also, besides financial services, other services like credit enhancement, credit rating, warehouse receipt transacting, and data auditing are all included in the platforms.

Secondly, **financing costs** can be reduced in several ways. In using the blockchain platform, much paper documentation can be abandoned. Ant Double Chain ensures that the issuance, split, circulation, financing, and clearing of accounts receivable can all be digitized. The cases of Suning Finance and Tencent Cloud demonstrate that shipments and the right delivery of goods can be recorded on the blockchain. The Bubi and Hyperchain cases suggest that BCT can provide customers with digitized certificate services. BCT makes it possible for the cumbersome manual processes of SCF to become more efficient (Hofmann et al. 2017).

Current onboarding processes, like Know Your Customer (KYC) checks involve duplication of work among financial institutions, leading to wasted time and money (Deloitte 2016). The Bubi Chain and Filoop SCF platforms (belonged to the Bubi Chain) allow the onboarding of multiple financial institutions, which ensures the secure flow of commercial data among financial institutions according to their authority. Smart contracts can firm up the clearing paths of funds, supporting the automation of transactions. Therefore, the blockchain platform can break information silos and interconnect data sources and stakeholders (EUBOF 2019). Also, the platform facilitates enterprises’ relationship building as well as online operations of complicated processes in SCF. This characteristic of BCT not only simplifies SCF processes but also reduces financing costs.

Regulatory costs can be cut back or eliminated. Suning Finance employed IoT technology to establish a blockchain-based platform aimed at a movable property pledge. With the support of video streaming media and machine vision, movable property stored in a warehouse can be scrutinized online through video surveillance. Combined with RFID, NFC (Near-field communication), sensors, and other IoT devices, the blockchain-based platform can automatically monitor the position, temperature, volume, weight, movement, and operators of movable property. Therefore, regulatory costs can reduce dramatically due to the lesser manual work needed.

Thirdly, BCT can improve **financing** **efficiency** in SCF. In the case of Ant Financial, SME suppliers in China had to receive bank acceptance bills a few months after their transactions with focal enterprises. However, BCT allows for the immediate issuance of digitized invoices, which means that suppliers can finance accounts receivable at sight immediately after transactions. Furthermore, BCT can improve financing speed significantly, making it possible for SME suppliers to receive funds within a day, because the smart contracts will automatically execute the transactions once the financing terms are agreed. Distributed ledger and point-to-point payment mechanisms weaken the role of intermediaries, leading to a decrease in the complexity of financing processes, helping to guarantee rapid and convenient financing services (Guo and Liang 2016).

In addition, although the traditional ABS instrument can be utilized to finance all kinds of assets with stable cash flow, including corporate loans, mortgages, consumer credit, and trade receivables. However, the underlying portfolio complexity and the involvement of multiple stakeholders tend to impede investment (Deku et al. 2021). A blockchain platform enables stakeholders to access information on these assets, which in turn benefits the platform in obtaining more funds, thereby improving overall financing service efficiency.

Finally, BCT is also beneficial for **risk management** in the SCF business. Supervising goods and inventory, along with paper-based documents, is an onerous task, as it is based on complex manual procedures exposed to human error, damage, loss, and even fraud or theft (Harris 2016). BCT allows for the digitization of paper-based documentation, removing the prospect of counterfeit invoicing. Asymmetric encryption algorithms and consensus mechanisms guarantee the security of financial business while maintaining the privacy of those who use it, which means customers will have less concern over personal information leakage (Zheng et al. 2017).

The cases of Suning Finance and Tencent Cloud suggest that the risks of inventory loss, damage, and theft decrease dramatically due to the implementation of BCT integrating with IoT technology, as dynamic inventory information can be obtained in real-time. Another risk borne by financing institutions is that SME suppliers may divert financing funds for purposes other than production operations. BCT guarantees that transaction data recorded on a blockchain is immutable and traceable, and thereby monitors the flow of funds. Also, smart contracts firm up the clearing path of funds, so borrowers cannot intentionally default on repayments. The blockchain functions in dealing with SCF challenges based on the five cases are overviewed in Table 2.

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# 5. The extended innovation adoption framework of BCT in SCF

According to the cross-case analysis, this section discusses and clarifies the findings, comparing them with the literature. In order to explore how enterprises manage the BCT adoption process to support SCF businesses, an extended framework of innovation adoption of BCT in SCF is proposed in Figure 3.

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## 5.1 Initiation phase of adopting BCT in SCF

The initiation phase consists of two stages: agenda-setting and matching. For the adoption of BCT in SCF, the agenda-setting stage embraces and unpacks the organizational needs to addressing any problems in the traditional SCF businesses. It can be triggered by opportunities and risks. From the cross-case analysis, we summarise the challenges in SCF as four key areas, namely high financing costs, limited access to SCF for lower tier suppliers, low efficiency, and high risk.

The emerging BCT is especially suitable for dealing with such challenges faced by the traditional SCF. Characterized by immutability, traceability, smart contracts, and decentralization, the BCT makes it possible to integrate resources on the chain, which enables on-chain data storage and business operations. Subsequently, the transaction data possess high credibility, which benefits the financial institution’s risk management. Also, digital invoices can overcome the deficiencies of traditional paper-based invoices in that they can be split online through the blockchain platform, which facilitates financing services for multi-tier suppliers. Furthermore, business operation processes can be moved from offline to online and paper-based documentation can be eliminated owing to the BCT, which is helpful for the improvement of financing cost reduction and efficiencies.

However, prior to the implementation phase, an organization’s SCF environment needs to be studied thoroughly to discern the potential fit with the BCT. As the essence of the BCT is to increase the credit of enterprises as a trusted machine (Kayikci et al. 2020), managers also need to evaluate whether it is essential for enterprises to implement blockchain-based SCF solutions because the obstacles in SCF may not originate from the lack of credit but other factors. Indeed, organizations still need long-term strategies to explore the feasibility of exploiting BCT in solving SCF problems.

In addition, a typical pattern can be found in the relationships among stakeholders when they decide to initiate the BCT adoption in SCF. In blockchain-based SCF solutions, stakeholders can be roughly divided into three categories: technology service providers (FinTech companies), supply chain companies (focal enterprises), and financial service providers (banks). All the launchers in these cases orchestrate their resources to collaborate with outside partners regardless of their category, to construct blockchain-based SCF platforms. As an important value of BCT lies in breaking the information silos among enterprises, multiple parties jointly operating the platform enables enterprises to take full advantage of blockchain characteristics to support SCF businesses. The pattern also has its advantages in that stakeholders involved in the platform can provide their particular resources with lower costs. The technology service provider can provide technical services and platform operating support, focal enterprises have business resources and data, and financial institutions bring financing capability (Hofmann et al. 2017). Thus, at this stage we propose as follows.

***Proposition 1****: When initiating blockchain adoption in SCF, multiple parties’ decision on jointly operating the blockchain-based SCF platform enables them to take full advantage of their inherent resources and blockchain characteristics.*

## 5.2 Implementation phase of BCT adoption in SCF

After the initiation phase, organizations need to exert considerable efforts to implement an innovation. The first stage in the implementation phase consists of bilateral adjustments, which are redefining and restructuring (Rogers 2003). On the one hand, BCT has to be adapted to the organization’s objectives and structures, which is known as redefining. On the other hand, the organization needs to execute structural adjustments to fit with BCT, known as restructuring. Until the bilateral adjustments are completed, the BCT can be gradually absorbed into ordinary SCF businesses in organizations. To deeply understand how the enterprises implement BCT to support SCF businesses, in this section, we analyze the common patterns among all the cases and explore the key factors of different adoption stages in promoting the adoption of BCT in SCF.

### 5.2.1 Redefining

When considering employing BCT in SCF, we need to learn whether the performance specifics of BCT are aligned with the actual requirements of the SCF. Generally, BCT can be divided into three types, including public blockchain, consortium blockchain, and private blockchain (Du et al. 2020). Transaction speed in public blockchain is relatively slow compared to existing payment transfers, which undermines the overall efficiency of blockchain-based SCF platform. Another factor with an impact on transaction efficiency is the degree of centralization. As clearing and settlement occur with transacting all at the same time, and each transaction needs to be verified by at least half of the nodes in the whole public blockchain network, the transaction speed in blockchain will be affected negatively when the number of blockchain nodes increase (Guo and Liang 2016). Compared to other two types, private blockchain lacks the characteristic of decentralization. Also, it cannot ensure the authentic and reliable information transfer among stakeholders. Consequently, consortium blockchain is more suitable for SCF; its lower level of decentralization will benefit transaction efficiency (Gai et al. 2019). Nonetheless, consortium blockchains also have their shortcomings compared with public blockchains. The latter can take advantage of the power of crowds, as a consensus mechanism is used to verify information and provide trust. However, consortium blockchains have fewer members, which may not be equal in the power of their discourse. In this case, whether a consensus mechanism is appropriate remains under discussion (O'Leary 2017).

Moreover, stakeholders may be faced with inconsistent incentives, which hinders the successful implementation of the BCT. First, as all the members participating in the blockchain platform have access to the data recorded in the platform, enterprises may refuse to implement blockchain solutions owing to the disclosure of business information (Hastig and Sodhi, 2020). Therefore, mechanisms that support or extend BCT need to be redeveloped or designed to cater for multiple scenarios in SCF. In all of the selected cases, channel mechanisms, data upload permission mechanisms, private data mechanisms, and multi-party encryption mechanisms have been developed for privacy protection (Du et al. 2020; Lahkani et al. 2020; Ma et al. 2019).

Second, SMEs want to have access to SCF businesses with lower costs, by adopting the BCT. However, the BCT adoption is accompanied by non-trivial costs, which may impede SMEs’ participation in blockchain solutions. The characteristics of the BCT enable it to better build trust among stakeholders without trusted third parties (Chod et al. 2020). Although data stored in the blockchain platform, with the characteristic of immutability, cannot be manipulated, making this technology outstanding in exchanging trusted data among related parties, it lacks the capability of discerning and avoiding fraudulent data from input sources. Likewise, if data entry on the blockchain is manual, it may lead to integrity or accuracy issues (van Hoek 2019).

To deal with these kinds of obstacles, combining BCT with other information technologies may provide a solution. Some blockchain-based solutions suggest integration with IoT technology, like sensors, because BCT cannot obtain data by itself. This not only ensures quality data are collected on the chain due to the expanded volume of data recorded (van Hoek 2019) but also is more convenient and cost-effective than manual data entry (Chen et al. 2020). Other devices like GPS trackers and RFID tags could also bring benefits, guaranteeing sufficient, accurate, and timely information about physical flows (Queiroz et al. 2021). Meanwhile, there are some cases where artificial intelligence (AI) and big data analysis (BDA) are deployed in blockchain systems to conduct data analysis, which can help in pattern recognition and guarantee data quality (EUBOF 2019).In the case of Suning Finance and Tencent Cloud, technology resources are orchestrated to advance the movable property pledge financing platform. The platform is equipped with machine vision, GPS tracker, IoT, BDA, and other technologies, which enable automatic supervision of the location, temperature, weight, and movement of movable property, and on the operators (Kshetri 2018). Thus, in order to overcome the disadvantage of BCT with regard to data entry, other technologies should be integrated in blockchain-based solutions.

However, the integration with other technologies requires additional resources. Also, the BCT adoption incurs both fixed costs and unit operational costs that SMEs may not be willing to afford, because exorbitant costs could harm SMEs’ benefits from blockchain-based SCF solutions. A possible solution to overcome this dilemma is to collaborate stakeholders in blockchain-based SCF solutions. On one hand, SMEs share more information on blockchain platform, which can be utilized by focal enterprises to calibrate demand forecasting (Yang et al. 2022). On the other hand, focal enterprises can afford the fixed costs of the BCT adoption and help SMEs with technical resource orchestration (Niu et al. 2021). Therefore, the incentives of stakeholders to participate in blockchain-based SCF solutions can be aligned.

From the analysis above, we can conclude that the incentives of stakeholders need to be balanced and coordinated, owing to the consideration from two perspectives. On one hand, the transactional throughput, latency, and size constraints of most blockchains and the inherent mechanisms will need to be adjusted to meet SCF needs. On the other hand, the BCT needs to be combined with other technologies, such as IoT, AI, and BDA, to act as a trusted machine in SCF businesses, as stated in proposition 2a.

***Proposition 2a****: In the redefining stage, the incentives of stakeholders need to be balanced and coordinated, as the redevelopment of BCT mechanisms and the combination with other technologies are needed to meet SCF requirements.*

### 5.2.2 Restructuring

Besides technology resource orchestration, the companies selected in our cases also orchestrated resources horizontally to overcome inter-organizational barriers, by restructuring their relationships with partners (Janssen et al. 2020; Saberi et al. 2019). For instance, multiple stakeholders in the ABS business collaborate with one another through a blockchain platform. The BCT breaks down information silos among business partners by a peer-to-peer network structure. After four categories of resource flow enter the chain – information, physical, financial, and business flows – the data can then be easily accessed by authorized parties (Kshetri 2018). This facilitates supply chain management by companies and supervision for transactions and asset information, in reverse factoring, inventory financing, and ABS, by financial institutions (Tönnissen and Teuteberg 2020; Wong et al. 2020). Nevertheless, the data of the four flows generated during supply chain activities contain certain privileged information or trade secrets, which may impede collaboration among stakeholders. Although the privacy protection mechanism is designed for the BCT, it is also necessary to reach a consensus on sharing information within and between enterprises, which enables the designed blockchain mechanisms to put into effect. Thus, when aiming to bridge information silos, not only a blockchain-based information-sharing mechanism with the premise of ensuring security and data privacy needs to be developed (Du et al. 2020; Ma et al. 2019), but also the coordination and cooperation among stakeholders are necessary (Blackman et al. 2013; EUBOF 2019).

Furthermore, it must be conceded that the existing data management systems in supply chains are mature, practical, and efficient, such as the order management system (OMS), warehouse management system (WMS), supplier relationship management (SRM), and enterprise resource planning (ERP) (Gunasekaran and Ngai 2004). The value creation from exploiting BCT in SCF comes from integrating it with existing systems because BCT can only ensure the authenticity and reliability of the recorded data, failing to replace the functions of existing systems (Hastig and Sodhi 2020). As a consequence, organizations at this stage need to focus on developing interfaces between BCT and the existing management systems in the supply chain, to improve interoperability and facilitate mass adoption (Pournader et al. 2020).

As an information technology, BCT can be a disruptive innovation and may connect and alter traditional information systems (Mougayar 2016). The effective integration of BCT with existing information systems requires coordination through intra-organization, as lack of knowledge and expertise impedes staff to convert to new systems (Saberi et al. 2019). Also, transitions from older systems to newer ones may modify organizational culture or power structures, which results in resistance from individuals and organizations (Jharkharia and Shankar 2005). In order to deal with friction or opposition to BCT uptake, organizations may need to adjust hierarchical structures and corporate culture to adapt to the integration. Accordingly, we propose:

***Proposition 2b****: In the restructuring stage, enterprises need to orchestrate resources to complement the blockchain-based SCF solutions through the coordination within and between organizations.*

Through the integration of the BCT and the existing systems, the BCT and the combined technologies enable financial institutions to collect authentic and reliable data along the supply chain, which benefits the credit enhancement of the capital-constraint enterprises. Also, the information silos can be broken down, leading to the more effective operations management among supply chain partners. Therefore, we propose:

***Proposition 2c****: The redefining and restructuring stages are interrelated through the integration of the BCT and the existing systems within SCF businesses.*

### 5.2.3 Pilot and large-scale implementation

When firms have accomplished the biliteral adjustments at the last stage, they need to consider putting blockchain-based SCF solutions into more widespread use both horizontally in organizations and vertically among multiple parties. In order to carve up this stage more specifically, we divide the clarifying stage of Rogers’ (2003) theory into two sub-stages, pilot and large-scale implementation (van Hoek 2019).

Firstly, we analyzed the clarifying stage from the perspective of pilot. From this aspect, we take the business model of reverse factoring in a single supply chain as an example. Although theoretically blockchain-based reverse factoring business enables the lower-tier supplier to obtain funds by financing digital invoices (Zheng et al. 2020), in practice the circulation of digital invoices may be hindered, as seen in the Hyperchain case. For instance, the tier-1 supplier received a digital invoice from the focal enterprise with an account period of 60 days. If the tier-2 supplier only accepted the digital invoice with an account period of 90 days, the circulation of invoices would be hindered owing to the mismatching account periods (Chen et al. 2020). A possible solution is constructing a blockchain-based invoice pool by designing a mechanism of smart contracts (Lycklama et al. 2017). This would promote the circulation of digital invoices by recording the overall amounts and mitigating against account period discordance.

From a large-scale implementation perspective, we consider the cross circulation of digital invoices among two or more supply chains. Still in reverse factoring business, after a digital invoice was issued by focal enterprise A and passed through multiple tiers, the circulation may be impeded under two scenarios. Regardless of whether digital invoices are circulated to the lower-tier suppliers in the same industry or another industry, the suppliers may resist the digital invoices because of their lack of understanding of the focal enterprise A. In order to award credibility to the digital invoices, an additional process of registering accounts receivable with the central bank may be added to their issuance to meet SCF objectives (van Hoek 2019).

The issues discussed above emerge from the pilot stage, but the adjustments still involve the redefining of BCT or the restructuring of organizations (Sia et al. 2004; Wuttke et al. 2013). Thus, feedback from the pilot stage to the redefining/restructuring stage is useful in enabling organizations to orchestrate resources both horizontally and vertically in the quest to improve the reliability and efficiency of blockchain-based SCF solutions. We propose:

***Proposition 3****: There is a feedback loop from the pilot stage to the redefining/restructuring stage, which facilitates organizations in improving the reliability and efficiency of blockchain-based SCF solutions.*

To realize widespread adoption of large-scale blockchain-based supply chains, more supply chain partners need to have motivations to participate in blockchain solutions, which enables BCT to play more value. On the one hand, more lower-tier suppliers can utilize the credit endorsement of focal enterprises to obtain loans through the blockchain platform, which facilitates the release of the potential market of SCF; on the other hand, the blockchain platform can also obtain more authentic and reliable data, which can be used by focal enterprises and financial institutions to identify potential demands and manage risks (Chang et al. 2019; Lohmer et al. 2020). On the contrary, if there are too few enterprises participating in the blockchain platform, the enterprises that adopt the BCT cannot use the blockchain-based SCF solutions effectively. On the one hand, the blockchain platform cannot obtain the data of the entire operation processes in the supply chain, which reduces the basis for enterprises’ credit enhancement; on the other hand, in the businesses that require that participation of multiple parties, such as inventory financing and ABS, if not all the stakeholders participate in the blockchain platform, the complex business processes cannot be fully realized on the blockchain platform. Under this circumstance, the blockchain-based SCF solutions are almost the same as the traditional SCF solutions, leading to the failure of the BCT.

In addition, legal, regulatory, and organizational hindrances must be overcome (Janssen et al. 2020; Saberi et al. 2019). Further, it is feasible that new laws and regulations may need to be created to promote BCT uptake. Global supply chains exist in an inconceivably complicated environment that demands multiple parties across many jurisdictions to conform to various laws and regulations (Kshetri 2018). Existing laws are insufficient to regulate multilateral businesses, and a unified legal framework is much needed (Hastig and Sodhi, 2020). Also, impediments to universally recognizing the legal status of blockchain transactions need to be resolved, as this would catalyze greater acceptance of BCT (EUBOF 2019). Thus, we propose to bridge the pilot and large-scale implementation stage.

***Proposition 4****: To realize the large-scale implementation of blockchain-based SCF solutions, (a) more stakeholders need to be motivated to participate in the blockchain platform, (b) and new laws and regulations need to be developed to promote the adoption.*

# 6. Discussion of the extended innovation adoption framework

In the previous analysis, we have developed four sets of propositions that indicates how enterprises adopt the BCT to support SCF businesses. Based on an extension of Rogers’ (2003) innovation adoption theory, it is possible to combine these propositions into a framework of BCT adoption in SCF as shown in Figure 3. As an asymmetrically encrypted distributed ledger, the BCT connects stakeholders in SCF with a peer-to-peer network structure, which enables it to break down information silos among enterprises. Also, stakeholders have access to provide their inherent resources more efficiently to support SCF businesses. Therefore, during the initiation phase of BCT adoption, multiple parties’ decision on jointly operating the blockchain-based SCF platforms enables them to take full advantage of their inherent resources and blockchain characteristics (P1).

Furthermore, the essential role of BCT is a trusted machine, which cannot be achieved alone without the internal and external adjustments of both the BCT and the enterprises. To ensure the reliability and the authenticity of the collected data and integrate business, physical, information, and financial flows, the BCT needs to be combined with other technologies, such as IoT, AI, and BDA. Also, the inherent mechanisms of the BCT, such as privacy protection mechanism, need to be redesigned to meet SCF requirements. However, as stakeholders may have different incentives of information sharing and resource orchestration, the incentives of stakeholders need to be balanced and coordinated to facilitate the adjustments of the BCT (P2a). The organizations need to learn the corresponding professional knowledge and adapt to the BCT (Gong et al. 2018). Moreover, the coordination among organizations is necessary, including resource orchestration and information sharing, which enables enterprises to complement blockchain-based SCF solutions (P2b). The redefining and restructuring stages are interrelated through the integration of the BCT and existing systems, based on which the bilateral adjustments between the BCT and enterprises can be utilized to support SCF businesses (P2c).

Next, when the BCT adoption enters the pilot stage, the unexpected issues may emerge. However, the adjustments of the BCT and organizations are still involved in the redefining and restructuring stages. Therefore, a feedback loop exists from the pilot stage to the redefining/restructuring stage, which facilitates organizations in improving the reliability and efficiency of blockchain-based SCF solutions (P3). Moreover, to realize the large-scale implementation of blockchain-based SCF solutions, more supply chain partners need to have motivations to participate in blockchain solutions, which enables BCT to play more value (P4a). Also, in global supply chains, multiple parties across many jurisdictions have to conform to various laws and regulations (Kshetri 2018), which impedes the universal recognition of blockchain transactions’ legal status. Thus, new laws and regulations need to be developed to promote large-scale implementation of the BCT in SCF businesses (P4b).

The main difference between our research and the study conducted by Wuttke et al. (2013) lies in the research perspective. Although both the studies employ the innovation adoption framework proposed by Rogers (2003), Wuttke et al. (2013) focuses on inter-departmental cooperation in SCF and how it can improve financial flows along the supply chain. Instead, our research focuses on the adoption of BCT and how it can overcome the challenges of traditional SCF. Wuttke et al. (2013) indicates that the alignment of departments and the collaboration among stakeholders are important for enterprises in absorbing SCF innovation. However, due to the lack of effective information sharing approaches, stakeholders in SCF are still lack of trust, which leads to the fact that the SCF potential cannot be fully leveraged (Jia et al. 2020; Wang et al. 2020). As a trusted machine, the BCT is able to improve trust among stakeholders and further support SCF businesses from four perspectives, including financing range, financing costs, financing efficiency, and risk management. For example, the reverse factoring replaces the traditional payment terms and can only benefit the first-tier suppliers from the reduction of capital costs. With the support of the BCT, blockchain-based reverse factoring is able to provide lower-tier suppliers with low-cost financial services. The findings of the study are also able to complement the research by Wuttke et al. (2013), as the effective adoption of the BCT not only facilitates the dissemination of SCF, but also facilitates the fully leveraging of SCF potential.

# 7. Conclusion

By applying a multiple case study method, this research has examined five pioneering companies who have adopted sophisticated blockchain-based SCF solutions. Focusing on innovation adoption, namely of BCT within organizations, we compare blockchain-based solutions with three business models in SCF and answer how enterprises adopt the BCT to support SCF businesses effectively. By doing so, we have developed four sets of propositions that characterize successful BCT adoption in SCF. Also, several significant theoretical contributions and managerial insights are drawn.

## 7.1 Theoretical contributions

First, our exploratory research has contributed to the research domain of the BCT and SCF, and it is among the early research on the application of the BCT in SCF, which can inspire future research on this topic. By examining five case examples on their blockchain-based SCF solutions, we categorize the challenges in the traditional SCF into four dimensions, including range, cost, efficiency, and risk. Also, we explain in detail why the BCT can cope with SCF challenges based on its characteristics from related aspects.

Second, this research has utilized the innovation adoption framework (Rogers 2003; Wuttke et al. 2013) to structure our findings about potential advantages and adoption issues of the BCT in SCF businesses. We further classify the clarifying stage into pilot and large-scale implementation stages which aligns with practices (van Hoek 2019). Also, we propose an innovation adoption framework of the BCT in SCF by offering four sets of testable propositions, linking internal and external management practices with the adoption process by organizations.

## 7.2 Managerial implications

Our research provides some practical managerial implications. Enterprises can adopt the BCT to improve SCF performance by following the extended innovation adoption framework developed in this paper. In the initiation phase, enterprises need to pinpoint the existing challenges and explore whether blockchain functions can solve them. If these match with each other, enterprises can consider the implementation process. When initiating blockchain adoption in SCF, multiple core partners should be included to run the pilot, which enables them to take full advantage of their inherent resources. With the progress of the BCT implementation, more stakeholders can engage in the solution to create more profits.

The first stage of the implementation process is redefining/restructuring, which is a mutual adaptation process between both the innovation and organization. On the one hand, inherent mechanisms of BCT need to be redesigned and other technologies, such as IoT, AI, and BDA, need to be combined to meet specific SCF requirements. On the other hand, enterprises need to orchestrate resources to complement the blockchain-based SCF solutions through the coordination within and between organizations. Moreover, The redefining and restructuring stages are interrelated through the integration of the BCT and the existing systems within SCF businesses. At the pilot stage, problems may emerge from the newly proposed solutions, which may provide ideas for organizations to apply readjustments in the redefining/restructuring stage. In order to achieve large-scale implementation, more stakeholders need to have motivations to participate in the blockchain-based SCF solutions. In addition, new laws and regulations need to be developed to recognize the legal status of blockchain transactions in global supply chains.

## 7.3 Limitations and future research direction

By utilizing a multiple case study method, this study has a limitation in generalizability. Although we deliberately selected cases with a clear rationale, it is not possible to confirm that the results in this paper can be transposed into other scholarly undertakings without some adjustments. The companies in our cases are pioneers in adopting BCT in SCF in China, although we acknowledged that there are more BCT-based SCF practices over the worlds. Therefore, these findings may not be entirely suitable for organizations in the large-scale implementation stage or in other regions. Also, this research is based on secondary-data, which may not be able to answer some in-depth how and why questions. The propositions identified in this research are in lack of strong arguments from interviews and thus need for further examination. In addition, this research only focuses on the potential advantages of the BCT on reverse factoring, inventory financing, and ABS, without the deep analysis of a specific BCT-based SCF business models. Therefore, this research also has the limitation in the fitness of findings into a specific BCT-based SCF business.

Our study also reveals some future research directions. First, researchers may adopt other methods such as interviews or surveys and use first-hand data to varify the propositions in this paper. Second, further research could try to explore the detailed business models of related BCT-based SCF applications, such as proper deep-tier financing approaches through interviews. Third, after blockchain-based SCF solutions are adopted in organizations, factors that affect their performances may also arouse researchers’ interests. For example, with the increasingly fierce competition between online and offline channels, how the channel competition and coordination impact the performances of blockchain-based SCF solutions may deserve further exploration. Fourth, in the future, as more and more enterprises can provide blockchain-based SCF solutions, performance evaluation models could be beneficial in investigations, which can assist enterprises in selecting suitable blockchain-based SCF solutions.

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**Table 1. Blockchain-based solutions across five cases**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Company | Instruments | Stakeholders in horizontal and vertical | Blockchain features | Dealing with SCF challenges  |
| Ant Financial | Blockchain-based reverse factoring | Focal enterprise, suppliers, banks, and fintech companies in horizontal | Blockchain-based supply chain network enabling the credit of focal enterprises to be transferred to lower-tier suppliers | Lower-tier SMEs’ difficulty in financing and lacking access to low-cost financing |
|  |  | Focal enterprise, suppliers, banks in vertical |  |  |
| Suning Financial | Blockchain-based inventory financing | Focal enterprise, retailers, banks, logistics service providers, and fintech company in horizontal | Blockchain combining with IoT, RFID, and AI technologies to realize the automatic supervision of physical flow during logistics processes and supervision data automatically recorded on the chain | High supervision costsFraudulent problems of paper-based documents and invoices |
|  |  | Focal enterprise, retailers, banks, logistics service providers in vertical |  |  |
| Tencent Cloud | Blockchain-based reverse factoring | Focal enterprise, suppliers, banks, and fintech companies in horizontal | Blockchain-based supply chain network enabling the credit of focal enterprises to be transferred to lower-tier suppliers | Lower-tier SMEs’ difficulty in financing and lacking access to low-cost financing |
|  |  | Focal enterprise, suppliers, banks in vertical |  |  |
|  | Blockchain-based inventory financing | Focal enterprise, retailers, banks, logistics service providers, and fintech company in horizontal | Blockchain combining with IoT, RFID, and AI technologies to realize the automatic supervision of physical flow during logistics processes and supervision data automatically recorded on the chain | High supervision costsFraudulent problems of paper-based documents and invoices |
|  |  | Focal enterprise, retailers, banks, logistics service providers in vertical |  |  |
| Bubi | Blockchain-based reverse factoring | Focal enterprise, suppliers, banks, and technology service providers in horizontal | Blockchain-based supply chain network enabling the credit of focal enterprises to be transferred to lower-tier suppliers | Lower-tier SMEs’ difficulty in financing and lacking access to low-cost financing |
|  |  | Focal enterprise, suppliers, banks in vertical |  |  |
|  | Blockchain-based ABS | Supply chain enterprises, banks, custodian, securities traders, SPV, and technology service provider in horizontal | Multiple parties taking part in the decentralized peer-to-peer network constructed by blockchain, which improves the efficiency of collaborative operations | Collaborative operation costs of multiple parties involved in ABS are high |
|  |  | Supply chain enterprises, banks, custodians, securities traders, and SPV in vertical |  | Complicated processes of ABS leading to lower efficiency and accuracy |
| Hyperchain | Blockchain-based reverse factoring | Focal enterprise, suppliers, banks, and technology service provider in horizontal | Blockchain-based supply chain network enabling the credit of focal enterprises to be transferred to lower-tier suppliers | Lower-tier SMEs’ difficulty in financing and lacking access to low-cost financing |
|  |  | Focal enterprise, suppliers, banks in vertical |  |  |

**Table 2. Blockchain functions in dealing with SCF challenges**

|  |  |  |  |
| --- | --- | --- | --- |
| SCF challenges | BCT functions (themes) | Sub-themes aggregation | Cases involved |
| Range | Financing-range | Lower-tier SMEs’ access to low-cost loans | Invoices are issued through the blockchain, which can be split and transferred to lower-tier suppliers, allowing them to be financed using split invoices. [1,3,4]Holding split digital invoices is equivalent to being endorsed by focal enterprises, which facilitates lower-tier suppliers to access low-cost loans. [1,3,4] |
|  |  | Provision of more services | Blockchain-based SCF platforms can provide more services, such as authentication, funds management, operations management, credit enhancement, data auditing, among others. [3,4] |
|  |  | A wider range of illiquid assets | With the support of blockchain technology, a wider range of illiquid assets in ABS businesses can be supervised by financial institution effectively. [3] |
| Cost | Financing cost | Elimination of paper-based documents | The processes of confirmation, circulation, financing, and settlement of accounts receivable can all run on blockchain. [1]IoT platform ensures that related information, such as goods purchase and shipment, can be stored on the blockchain, which is safe and reliable. [2]The platform sets up a profit allocation mechanism of split and circulation of accounts receivable, ensuring accounts receivable circulating along the multi-echelon supply chain. [3]All financial invoices generated by trade are securely, completely, and permanently registered in distributed ledgers as digital assets. [4] |
|  |  | Reduction in processing costs | Smart contracts allow the automatic execution of multi-tier remittances, reducing banks’ own business expansion risks and marginal costs under multi-tier financing business models. [3]Bubi facilitates traditional ABS business by coordinating stakeholders on the chain, including brokers, legal offices, banks, special purpose vehicles (SPV), and enterprises in the supply chain. [3] |
|  |  | Reduction in regulatory costs | The movable property pledge financing system uses machine vision, GPS, sensors, and other technologies, to achieve automatic monitoring of the position, temperature, volume, weight, movement, and operator status of movable property. [2] |
| Efficiency | Financing efficiency | Fast fund receipt | Financing loans can be settled online in near-real-time (T + 0), which significantly improves the financing efficiency of suppliers. [3]The approval speed of financing businesses reaches the second level, and funds can be received in real-time. [4] |
|  |  | Invoice issuance on-chain immediately after transactions | The blockchain-based SCF platform allows for the immediate issuance of digital invoices, which means that suppliers can receive digital invoices at sight and finance the accounts receivable. [1] |
|  |  | Simplification of manual processes in financial businesses | The processes of confirmation, circulation, financing, and settlement of accounts receivable can all run on the blockchain. [1]The movable property pledge financing system uses machine vision, GPS, sensors, and other technologies in the automatic monitoring of the position, temperature, volume, weight, movement, and operator status of movable property. [2]Smart contracts allow the automatic execution of multi-tier remittances, reducing banks’ own business expansion risks and marginal costs under multi-tier financing business models. [3] |
|  |  | Provision of information of related assets | Stakeholders in ABS have access to information flows of underlying assets through the blockchain platform. [3] |
| Risk | Risk management | Inability of borrowers to default deliberately | Smart contracts firm up the clearing path of funds, which reduces default risk by suppliers. [1]Smart contracts allow the automatic execution of multi-tier remittances, reducing banks’ own business expansion risks and marginal costs under multi-tier financing business formats. [3] |
|  |  | Avoidance of fraudulent invoices | Blockchain ensures that invoices issued or recorded on the chain are immutable and traceable. [1,2,3,4] |
|  |  | Reduction in regulatory risk | The movable property pledge financing system uses machine vision, GPS, sensors, and other technologies in the automatic monitoring of the position, temperature, volume, weight, movement, and operator status of movable property. [2] |

**Appendix A Background of case companies**

|  |  |  |
| --- | --- | --- |
| Data | Type of data source | Data source |
| Ant financial | Consulting report | China Blockchain + Supply Chain Finance report (2019). Available at: <http://report.iresearch.cn/wx/report.aspx?id=3410> [Accessed April 5, 2020].China Blockchain Finance Report (2019). Available at: <https://www.iresearch.com.cn/Detail/report?id=3501&isfree=0> [Accessed April 18, 2020]. |
|  | Company annual report | Alibaba Group Holding Limited 2020 Annual and transition report. Available at: <https://otp.investis.com/clients/us/alibaba/SEC/sec-show.aspx?FilingId=14266295&Cik=0001577552&Type=PDF&hasPdf=1> [Accessed August 1, 2020]. |
|  | Website | AntChain. Available at: <https://antchain.net>. [Accessed April 9, 2020]Ant Blockchain BaaS, Tested in Real Business Applications. Available at: https://www.alibabacloud.com/blog/ant-blockchain-baas-tested-in-real-business-applications\_595264 [Accessed April 9, 2020].Demystifying Ant Double Chain. Available at: https://yq.aliyun.com/articles/691420?utm\_content=g\_1000043203 [Accessed April 7, 2020]. |
| Suning Finance | Consulting report | China Blockchain + Supply Chain Finance report (2019). Available at: <http://report.iresearch.cn/wx/report.aspx?id=3410> [Accessed April 5, 2020].China Blockchain Finance Report (2019). Available at: <https://www.iresearch.com.cn/Detail/report?id=3501&isfree=0> [Accessed April 18, 2020]. |
|  | Company annual report | Suning Tesco Group Co., Ltd. 2018 Annual Report. Available at: https://www.suning.cn/static///snsite/contentresource/2019-04-01/6717f56f-d948-454e-a388-35a3b8cfd568.PDF [Accessed April 5, 2020]. |
|  | Website | Suning was Praised for Its “Blockchain + Internet of Things” Financing Platform for Cars. Available at: https://news.8btc.com/suning-was-praised-for-its-blockchain-internet-of-things-financing-platform-for-cars [Accessed April 5, 2020]. |
| Tencent Cloud | Website | Tencent Cloud. Available at: <https://intl.cloud.tencent.com/zh/> [Accessed November 1, 2021].Tencent Cloud Releases Supply Chain Finance Smart Service Platform to improve financing efficiency for enterprises. Available at: <https://tech.huanqiu.com/article/3xT4hHi1gde> [Accessed November 1, 2021]. |
| Bubi | Consulting report | China Blockchain + Supply Chain Finance report (2019). Available at: <http://report.iresearch.cn/wx/report.aspx?id=3410> [Accessed April 5, 2020].China Blockchain Finance Report (2019). Available at: <https://www.iresearch.com.cn/Detail/report?id=3501&isfree=0> [Accessed April 18, 2020]. |
|  | Website | Yinuo Supply Chain. Available at <https://www.yinuojr.cn>. [Accessed at April 5, 2020]. |
| Hyperchain | Consulting report | China Blockchain + Supply Chain Finance report (2019). Available at: <http://report.iresearch.cn/wx/report.aspx?id=3410> [Accessed April 5, 2020].China Blockchain Finance Report (2019). Available at: <https://www.iresearch.com.cn/Detail/report?id=3501&isfree=0> [Accessed April 18, 2020]. |
|  | Website | Hyperchain. Available at <https://www.hyperchain.cn>. [Accessed at April 5, 2020]. |

**Figure 1. Innovation adoption process in organizations**



Source: Rogers (2003)

**Figure 2. Thematic data analysis process**



**Figure 3. Innovation adoption framework of BCT in SCF**



Source: adapted from Rogers (2003)