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Blockchain Applications to Mitigate the Effects of Supply Chain Disruptions

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Emergent Research Forum (ERF)

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Abstract

The inherent nature of complex relationships among partners made the supply chain (SC) prone to disruptions. The SC disruptions have severe negative consequences on SC performance. Firms are constantly seeking appropriate strategies that can mitigate the effects of SC disruption. The extant literature in information systems suggests that modern technologies can be used in the supply chain to mitigate the risks caused by SC disruptions. Blockchain is a novel disruptive technology that has promising applications in the supply chain. Because of its special characteristics, blockchain is perceived to be immutable, secured, and transparent. As a part of mitigating strategy, this paper shows how adoption of blockchain technology can lessen the detrimental effects of SC disruptions by developing SC capabilities. The blockchain-enabled SC capabilities are flexibility, traceability, transparency, visibility, collaboration, and trust.

Keywords

Blockchain, supply chain disruptions, supply chain capabilities.

Introduction

Supply chains are fundamentally fragile, and therefore, they are more prone to disruptions caused by unforeseen incidents (Albertzeth et al. 2020; Craighead et al. 2007). There are numerous sources of supply chain disruptions, ranging from a mouse-click (cyberattack) to natural disasters (COVID-19) (Bode and Macdonald 2017). The consequences of supply chain (SC) disruptions could be a temporal disturbance or a complete shutdown of operations and distributions. For example, some disruptions, e.g., transportation disruption, may stop the movement of goods, but other activities of the chain remain uninterrupted (Albertzeth et al. 2020). On the other hand, other disruptions such as COVID-19 and Tsunami completely stop the productions and distributions of goods and materials. In some cases, SC disruptions can have a significant detrimental impact on the company's financial, market, and operational performance (Ambulkar et al. 2015). Specifically, SC disruptions pose severe threats to SC performance (Albertzeth et al. 2020; Ambulkar et al. 2015; Azadegan et al. 2020; Butt 2021; Craighead et al. 2007).

To mitigate the effects of such disruptions in SC, firms are constantly devising strategies (Albertzeth et al. 2020; Butt 2021; Craighead et al. 2007; Kumar and Sharma 2021). From academic standpoint, researchers are also investigating how the effects of disruptions can be reduced (Ambulkar et al. 2015). The applications of modern technologies in supply chain could be a great solution to such SC disruptions. Butt (2021) stressed the importance of digital technologies on building supply chain capabilities to fight against disruptions. Golgeci and Ponomarov (2013) posited that firms with innovative technologies can better manage SC disruptions. On the other hand, due to the poor technological capability and lack of advanced supply chain system, firms may require long time to recover from SC disruptions (Alora and Barua 2020). Blockchain is one of the novel technologies that can be promising to mitigate the effects of SC disruptions because of its special characteristics (Sheel and Nath 2019). The salient features of blockchain technologies have made its applications in supply chain more attractive (Cole et al. 2019; DHL 2018; van Hoek 2019). In context of supply chain, the features include traceability, visibility, and security; thereby enhancing collaboration, transparency, and trust in supply chain partners. In this study, we will explore how blockchain technology can mitigate the detrimental effects of SC disruptions developing SC capabilities.

Concept Development

Supply Chain (SC) Disruptions

As the chain largely depends on external parties, it is, therefore, exposed to several disruptions that may emerge from any party in the chain (Bode and Macdonald 2017). SC disruptions can be defined as unforeseen event that interrupts the normal flow of supply chain operations (Ambulkar et al. 2015). The sources of SC disruptions could be from demand, supply, regulatory, infrastructure, or catastrophe (Filbeck and Zhao 2020). Porterfield et al. (2012) categorized SC disruptions as natural disaster and manmade. Once the disruption occurs, it bears severe negative consequences for the firms (Ambulkar et al. 2015). Specifically, it carries burdens on supply chain performance (Azadegan et al. 2020). The negative consequences of SC disruptions on supply chain are outlined in Table 1 with literature support.

Negative consequences of SC disruptions on supply chain	Literature support
Stoppage in production of goods; increase of inventory management costs	Alora and Barua (2020); Bode and Macdonald (2017); Hendricks and Singhal (2008)
Premium freight charges and product substitutions.	Bode and Macdonald (2017); Hendricks and Singhal (2008)
Additional transactions, overtime and penalties paid to customers	Hendricks and Singhal (2008)

Table 1: Negative Consequences of SC Disruptions

Based on the literature support, we can argue that SC disruptions bear negative consequences on supply chain and thereby, reducing supply chain performance.

Adoption of Blockchain to Mitigate the Effects of SC Disruptions

Blockchain

Blockchain is a distributed ledger that exchanges information in peer-to-peer network without any intermediaries (Frizzo-Barker et al. 2020). The transactions are added to the network sequentially as blocks using cryptography (Chang and Chen 2020). The blockchain has some salient features that make the technology unique, compared to other technologies, e.g., RFID, Big data. These features are distributed ledger, consensus-based data addition, immutability, security, and transparency (Casino et al. 2019; Frizzo-Barker et al. 2020). These key features of blockchain technology increase traceability, transparency, collaboration and integration in supply chain, thereby enhancing visibility, trust, and adaptability in supply chain (Chang and Chen 2020; Queiroz et al. 2021).

SC Capabilities

As the supply chain has inherent vulnerabilities, firms constantly devise strategies to lessen or prevent from the detrimental effects of SC disruptions. To mitigate the impact of SC disruptions, supply chain must develop SC capabilities that can enable the supply chain to be operating as normal as possible after any disruptions (Azadegan et al. 2020). Supply chain capability (SCC) refers to the capability to use internal and external resources to coordinate the supply chain and daily operational activities (Wu et al. 2006). Capability means that a firm needs to be so managed and organized that it can exploit the full potential of its resources. Kovács and Falagara Sigala (2021) argued that SC capabilities can combat against SC disruptions. They suggested to build SC capabilities including supply chain flexibility, agility, responsiveness and resilience. In turbulent environment, building and managing the right capabilities are critical for success and survival (Golgeci and Ponomarov 2013). The supply chain capabilities include flexibility (Kovács and Falagara Sigala 2021), collaboration (Albertzeth et al. 2020), visibility (Butt 2021), transparency (Akyuz and Gursoy 2020), and traceability (Akyuz and Gursoy 2020). Therefore, we argue that right capabilities can reduce the impact of SC disruptions.

Adoption of Blockchain to Develop SC Capabilities

The initial application of blockchain was in cryptocurrency industry (Nakamoto 2008). These days, the potentiality of blockchain application spanned other areas: real estate, healthcare, supply chain, agriculture and cybersecurity, to name a few. The most important application of blockchain is in supply chain (Cole et al. 2019; DHL 2018; Queiroz et al. 2019). The benefits of using blockchain in SC have been studied in previous research (Kopyto et al. 2020; Lambourdiere and Corbin 2020; Moosavi et al. 2021; Queiroz et al. 2021; Sheel and Nath 2019). The blockchain enables supply chain partners to share real-time, accurate and visible transactions in the network. Min (2019) and Tonnissen and Teuteberg (2020) argue that the increased visibility enables them to make better forecasts and react instantly if any disruptions arise. Similarly, Sheel and Nath (2019) posited that blockchain increases visibility and transparency in supply chain. Table 2 describes how blockchain can develop capabilities that reduce the detrimental effects of SC disruptions.

Conceptual Model

Based on the arguments made above, we argue that blockchain enhances SC capabilities that, in turn, reduce the detrimental effects of SC disruptions on SC performance. Figure 1 depicts the conceptual framework of blockchain enabled SC capabilities to mitigate the negative impacts of SC disruptions on SC performance.

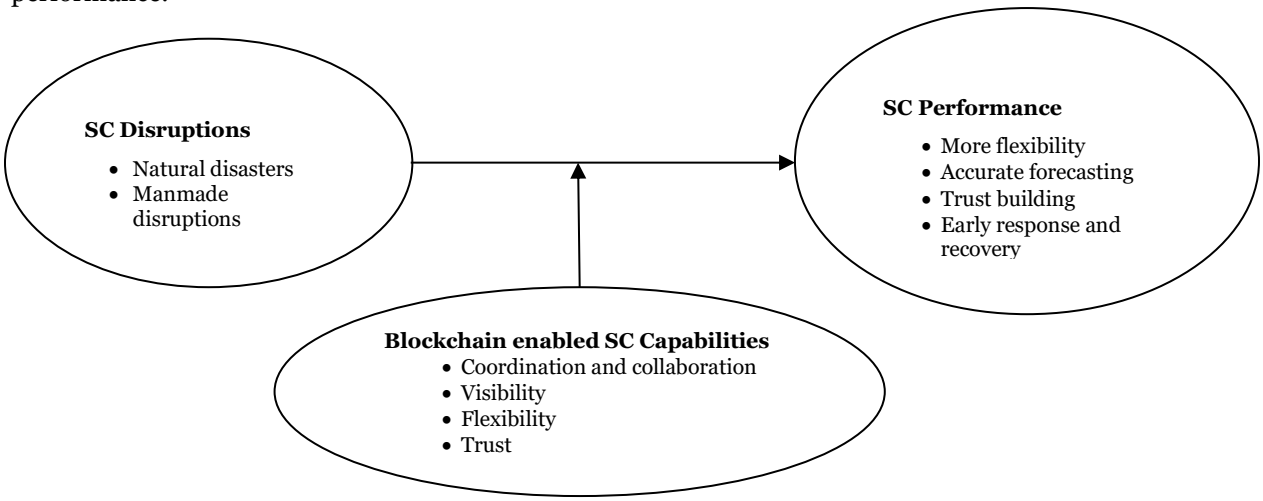

Figure 1: Conceptual Model

SC Capabilities	Blockchain's Interventions	Literature support
Collaboration	Blockchain enhances collaboration in SC in the following ways: • bringing all partners under one distributed infrastructure • offering a trusted collaborative ecosystem • eliminating intermediation. Thus, blockchain enables collaborative approach that reduces forecasting errors in any disruptive environment.	DHL (2018); Silvestro and Lustrato (2014)
Flexibility	Flexibility refers to the ability to respond to and adapt to any changes caused by disruptions. Blockchain can track and trace orders and therefore, it is able to adjust orders or demands accordingly as quickly as possible.	Akyuz and Gursoy (2020); Cole et al. (2019); Min (2019)
Visibility	Visibility refers to the availability of information in supply chain partners when they need it. Blockchain enhances visibility by sharing real-time data among supply chain partners.	Saberi et al. (2018); Caridi et al. (2014); Rogerson and Parry (2020)

Trust	The secured nature of blockchain enhances the trustworthiness among supply chain partners. This makes them share important information, which helps respond to any changes caused by disruptions. Also, trust enhances collaboration and coordination among supply chain partners.	Findlay (2017)

Table 2: Blockchain enabled SC capabilities

Methodology

A survey method will be employed to collect data for this study. The unit of analysis will be organizations that adopted blockchain or have intention to adopt, and the unit of observation will be supply chain professionals operating in different industries. These participants should have at least three years of experience with blockchain-related projects in the SCM field (e.g., interaction with suppliers projects, organization studies to adopt).

Conclusion

Supply chain disruptions have severe detrimental effects on supply chain performance. This paper presents a conceptual model that shows how blockchain can develop supply chain capabilities in order to mitigate the negative consequences of SC disruptions. The blockchain enabled SC capabilities are traceability, transparency, visibility, collaboration and trust. This paper also provides a useful basis for further empirical research by suggesting the relationships among SC disruptions, blockchain enabled SC capabilities and SC performance. In full paper, additional details of empirical results along with lessons and implications will discussed.

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