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Blockchain Adoption for Trusted Supply Chain: A Preliminary Study of Key Determinants

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Blockchain Adoption for Trusted Supply Chain: A Preliminary Study of Key Determinants

Research-in-progress

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Abstract

Despite the promising capability to help organisations inaugurate their trusted supply chains, blockchain technology has not been widely adopted due to several adoption inhibitors. As opposed to prior blockchain literature that mostly focused on the direct effect of technology-related factors, this research-in-progress paper offers a new perspective of holistic examination of key determinants of an organisation's intention to adopt blockchain. The paper also develops a conceptual model of blockchain adoption for supply chain context grounded on the integration of the technology-organisation-environment (TOE) and the extended valence frameworks. Specifically, three technological factors, two organisational factors, and two environmental factors directly influence an organisation's intention to adopt blockchain. Moreover, trust influences blockchain adoption intention indirectly through performance expectancy and risk of system security. The study offers a contribution to academics regarding the critical determinants of blockchain deployment for establishing trusted supply chains.

Keywords blockchain, supply chain, key determinants, trust, research-in-progress

1 Introduction

In recent years, the issue of trust deterioration has been raised as one of the main concerns for supply chain management across multiple industries (Guenther 2020). CEO and executives agree that those who survived and thrived in this era of high uncertainties and dynamisms need to maintain and enhance trust in supply chain relationships (Rajah 2019). Coincidentally, the concurrent arrival of newfangled blockchain technology gives a silver lining to help organisations achieve their desirable trusted supply chain. Blockchain is capable of enabling information sharing of all created transactions to all participants within the network in a real-time fashion (Nakamoto 2008). With such a promising capability, many supply chain scholars and practitioners expect blockchain to create an ecosystem that allows supply chain members to trustily exchange information with each other (Hawlitschek et al. 2018). In other words, blockchain can facilitate the establishment of 'trusted supply chain'.

Although blockchain capability to create a trusted supply chain seems to be pervasive, a few studies indicate that the adoption rate of blockchain is relatively low. For example, the Australian Computer Society (2019) revealed that even though 83% of Australian practitioners are aware of the blockchain benefits, only 20% have implemented or plan to implement in the next few years. This might be because of a multiplicity of technical challenges as well as organisational related inhibitors that hold back the organisation's intention to adopt blockchain.

Recently, there are a few preliminary studies that empirically investigated blockchain adoption determinants in the supply chain context (e.g. Clohessy and Acton 2019; Wong et al. 2020a). Several determinants have been identified as critical for an organisation's decision to adopt blockchain in a certain context. Nonetheless, there are two gaps manifesting in previous studies. First, a close look at these studies reveals that most of them focused on technology-related factors (Saberi et al. 2019). They emphasised how specific features of blockchain technology and its expected performance affect adoption decisions (e.g. Kamble et al. 2018; Wong et al. 2020b). External determinants such as trust and willingness to collaborate among supply chain participants are underexplored. Second, prior literature merely focused on the direct effect of each identified determinant on an organisation's behavioural intention to adopt blockchain. Nevertheless, previous information system studies have suggested that some technology adoption determinants can also have an indirect effect on another determinant. For instance, trust of supply chain partners was found to have both direct and indirect influences on the adoption intention of inter-organisational information systems (Trang et al. 2014). Therefore, to enhance the current understanding of blockchain adoption determinants, we formulate the following research questions:

1. *What are the key determinants that are likely to affect blockchain technology adoption for achieving a trusted supply chain?*
2. *How can these determinants affect an organisation's intention to adopt blockchain technology?*

This research-in-progress paper takes the first initial step by identifying key determinants of blockchain adoption in the context of a trusted supply chain from the existing literature. These determinants are grouped into three categories grounded on the technology-organisation-environment (TOE) framework, leading to the development of the proposed model of blockchain adoption. Specifically, the model shows that there are three technological factors, two organisational factors, and two environmental factors affecting an organisation's intention to adopt blockchain. Furthermore, the utilisation of the extended valence framework also indicates that inter-organisational trust indirectly affects blockchain adoption intention through influence placed on performance expectancy and the risk of system security.

2 Literature Review

2.1 Blockchain definition and application for trusted supply chains

Blockchain technology was initially coined by Nakamoto (2008) as a distributed data infrastructure consisting of a number of ledgers, each of which automatically records digital information and shares it with other ledgers within the network. The application of blockchain in supply chains is believed to help all participants within the network receive real-time information tracking of all activities happening in a supply chain in a nearly real-time fashion (Crosby et al. 2016). With such promising capability, blockchain application in supply chains is expected to help enhance information transparency, information authenticity, and speed of information processing which collectively lead to the establishment of a trusted supply chain ecosystem (Pan et al. 2020).

2.2 Theoretical Framework

2.2.1 Technology–organisation–environment Framework

Originally developed by Tornatzky et al. (1990), the TOE framework provides a holistic view of the multitudes of factors that might play roles in an organisation's adoption process of new technology. The framework systematically organises such factors into three main categories namely technology, organisation and environment. The framework has been utilised as a foundation in identifying technology adoption determinants by information systems and supply chain scholars in various studies such as the adoption of radio-frequency identification (RFID) (Kim and Garrison 2010), and cloud computing (Gangwar et al. 2015).

2.2.2 Extended Valence Framework

Firstly proposed by Kim et al. (2009), the extended valence framework refers to a benefit-risk evaluation of an individual's decision-making process which affects their intention to purchase new technology. The framework incorporates three main determinants that can directly influence consumers' purchasing intention namely perceived benefit, perceived risk, and trust. The framework also states that trust can have an indirect influence on the purchase intention through the influence placed on perceived benefit and risk. Although originally used in consumer adoption studies, the extended valence framework has been widely utilised by information system and supply chain scholars in the organisation-level studies of new technology adoption such as the adoption of IoT (Tu 2018) and e-commerce (Cui et al. 2019). In those studies, the framework is used to explore how existing trust between organisations impact the adoption decision. Thus, the framework is appropriate for this study as it facilitates the investigation of the impact of inter-organisational trust on blockchain adoption for trusted supply chains.

Determinant Identification

By adopting the TOE and extended valence framework as our underlying framework for analysis, we review existing literature of blockchain adoption in supply chain contexts and identify seven determinants in the three main categories as shown in Table 1.

Category according to the TOE framework	Determinants of Blockchain Adoption	Examples of Supporting Articles
Technological Factors	1. Technological complexities 2. Performance expectancy 3. Risk of system security	Gonczol et al. (2020); Queiroz and Wamba (2019); Wang et al. (2019)
Organisational Factors	4. Technology readiness 5. Organisational readiness	Clohessy and Acton (2019); Wong et al. (2020b)
Environmental Factors	6. Inter-organisational trust 7. Collaboration among supply chain partners	Farooque et al. (2020); Wamba and Queiroz (2020)

Table 1. Determinants of Blockchain Adoption based on the TOE framework

3 The Proposed Model and Hypotheses

Grounded on the TOE and extended valence frameworks, we develop a conceptual model to illustrate the relationships between blockchain determinants and an organisation's adoption intention as shown in Figure 1. In essence, seven identified determinants show a direct impact on behavioural intention to adopt blockchain. Besides, by utilising the extended valence framework, we also identify the influence of trust in other supply chain partners on the factors of perceived performance expectancy and perceived risk of blockchain security. This means that trust also shows an indirect impact on blockchain adoption through the mediating effect placed on other determinants.

3.1 Technological Factors

3.1.1 Technological Complexity (-)

Technological complexity refers to the extent to which an organisation perceived complexity or the ease of usage in the blockchain execution (Wong et al. 2020a). Previous literature has indicated that technology users are likely to accept and adopt new technology if they believe it does not require too

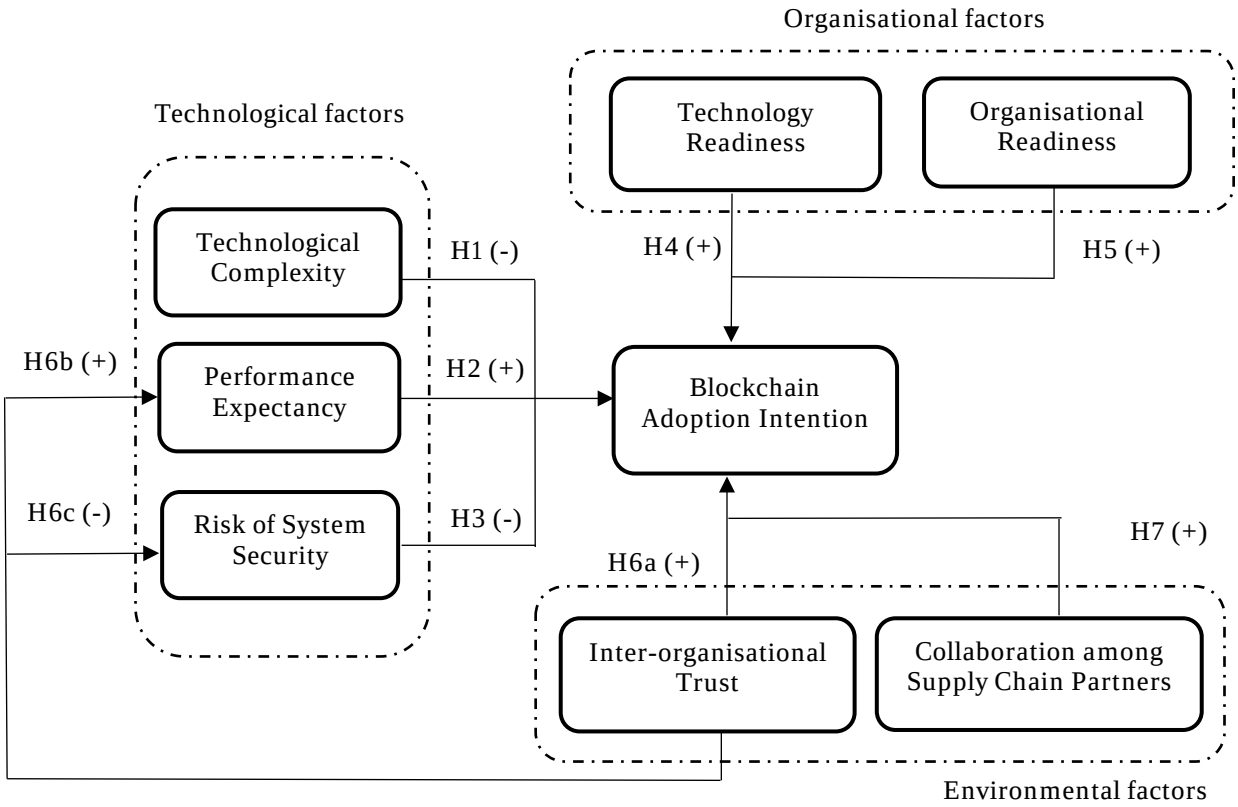

Figure 1: Conceptual Model: Blockchain Adoption Determinants in Supply Chain Context

much effort to learn how to use it (Gangwar et al. 2015). Although the blockchain application of self-executing smart contracts would reduce users' operating effort in the longer time window (Queiroz et al. 2020), at this stage, blockchain technical complexity is likely to be a daunting challenge for new users to understand. In short, technology complexity can reduce an organisation's intention to adopt blockchain.

Hypothesis 1: Technological complexity has a negative effect on blockchain adoption intention.

3.1.2 Performance Expectancy (+)

Performance expectancy refers to the extent to which an organisation expects that the use of new technology will improve the efficiency and performance of their related operating functions (Queiroz and Wamba 2019). Blockchain adoption has multiple theoretical merits to supply chain management processes such as an increase in the communication process between supply chain and an improvement of process traceability and trackability partners (Shoaib et al. 2020). An organisation is likely to compare these blockchain benefits with its current operating systems. If an organisation has a higher expectation that implementing blockchain will help improve supply chain-related performance, their intention to adopt such technology is then likely to be increased. Therefore, we postulate the following hypothesis:

Hypothesis 2: Performance expectancy has a positive effect on blockchain adoption intention.

3.1.3 Risk of System Security (-)

Risk of system security refers to the extent to which an organisation perceives that information in the blockchain system is unprotected from unauthorised access and vulnerable to hacking (Wang et al. 2019). Although, hypothetically, blockchain features can substantially increase system security, at this stage in which the technology is still immature, the security strength of blockchain is still a primary concern for a few organisations (Papathanasiou et al. 2020). Particularly, the employment of blockchain requires participating organisations to disclose their sensitive business information to others in order to increase the transparency of their supply chain, superior security is then required to protect such shared information from unauthorised access. If an organisation still shows a high level of concern for information security of the blockchain platform, their intention to adopt blockchain is likely to be reduced. Hence, we propose the following hypothesise:

Hypothesis 3: Risk of system security has a negative effect on blockchain adoption intention.

3.2 Organisational Factors

3.2.1 Technology Readiness (+)

Technological readiness refers to the extent to which the requisite technological infrastructure for blockchain execution is internally available in an organisation (Wamba and Queiroz 2020). Blockchain is a complex technology that requires an appropriate enterprise data architecture model to function the system effectively. Organisation also needs to ensure the interoperability between existing software and blockchain platforms (Kayikci et al. 2020). This is the case for small and medium enterprises, as they have limitations in infrastructure (Gonczol et al. 2020). Lack of technology readiness could be the main reason for resistance to adopt blockchain since if the technology infrastructure is not supportive, it will be difficult to reach the full capacity of blockchain. Hence, we propose the following hypothesis:

Hypothesis 4: Technology readiness has a positive effect on blockchain adoption intention.

3.2.2 Organisational Readiness (+)

Organisational readiness refers to the extent to which various resources such as human and financial capital are internally available within an organisation (Sternberg et al. 2020). Clohessy and Acton (2019) expounded that when organisations have a high level of readiness for new technology, their management team and staff are more likely to actively engage in the adoption project, put greater effort to complete their assigned tasks, and become more collaborative. This kind of organisation's climate is noticeably helpful for the effective implementation of blockchain. On the contrary, if an organisation has limited supportive resources, its intention to adopt blockchain is likely to be dropped.

Hypothesis 5: Organisational readiness has a positive effect on blockchain adoption intention.

3.3 Environmental Factors

3.3.1 Inter-organisational Trust (+)

Inter-organisational trust refers to the extent to which an organisation believes that other supply chain members' action will uphold their responsibilities and meet the agreed expectations without an organisation's ability to control or monitor (Queiroz and Wamba 2019). As blockchain requires all organisations to share their sensitive business information with others within the network, inter-organisational trust must be established in the first place. Typically, in the context of implementing a technology that transcends the boundary of a single organisation, the trust of other partners predetermines the intention to use such technology (Trang et al. 2014). Specifically, for blockchain, trust is inextricably connected to the blockchain consensus algorithm and is likely to be powerful enough in influencing an organisation's adoption intention (Wamba and Queiroz 2020). Hence, we propose:

Hypothesis 6a: Inter-organisational trust has a positive effect on blockchain adoption intention.

In past literature, inter-organisational trust shows its critical role in determining performance expectancy in technologies that transcend organisation boundaries, as these technologies only function effectively when all participants are on board (Trang et al. 2014). As the main functions of blockchain revolve around information exchange and transaction governance among supply chain participants, the performance of the technology then relies on the decisions and actions of such multiple participants. If an organisation perceives that its partner is likely to continuously share information, participate in reciprocal relations, and not behave opportunistically, such organisation will place a higher level of trust in its partners and expect a higher performance of blockchain adoption.

Hypothesis 6b: Inter-organisational trust has a positive effect on performance expectancy.

Same as other inter-organisational technologies, blockchain execution involves multiple parties in a supply chain, there is an opportunity for information leaks and hacking if any participant conducts opportunistic behaviours (Fang et al. 2014). Even though blockchain installation is expected to enhance system security, at this stage, a few organisations still show their serious concerns on security issues especially when blockchain requires them to enter sensitive or confidential business information (Papathanasiou et al. 2020). Therefore, trust bestowed to other partners is a prerequisite for reducing perceived risks of system security causing by such opportunistic behaviours.

Hypothesis 6c: Inter-organisational trust has a negative effect on the risk of system security.

3.3.2 Collaboration among Supply Chain Partners (+)

Collaboration among partners refers to the extent to which organisations within a supply chain are willing to share their information, knowledge and best practice with one another, as well as collaborate

in various activities (Farooque et al. 2020). Similar to other inter-organisational technologies, blockchain only reaches its full potential when all supply chain members agree to be onboard (Kshetri 2018). In the situation that an organisation has established reciprocal relationships with other supply chain partners in which they have shown their commitments to support others historically, such an organisation will be likely to expect a good collaboration when executing blockchain, which in turn increases its propensity to adopt the technology. Hence, we propose the following hypothesis:

Hypothesis 7: Collaboration among supply chain partners has a positive effect on blockchain adoption intention.

4 Conclusion

This research-in-progress paper is among the first to illustrate the conceptual model of blockchain adoption determinants grounded on the combination of the TOE and extended valence frameworks. We identify seven blockchain adoption determinants from previous literature which comprises three technological factors, two organisational factors, and two environmental factors. Our model highlights that performance expectancy, technology and organisation readiness, trust and collaboration among supply chain partners are expected to play roles as facilitators for blockchain adoption. On the contrary, technological complexity and risk of system security are likely to be the main inhibitors for an organisation's intention to implement blockchain. These facilitators and inhibitors are similar to key factors commonly identified in other technology adoption studies such as RFID (Kim and Garrison 2010) and cloud computing adoption (Gangwar et al. 2015). Likewise, our model also highlights that inter-organisational trust can also have an indirect impact on an organisation's intention to adopt blockchain through its influence placed on performance expectancy and the risk of blockchain security.

The next step of our research is to conduct multiple case studies to investigate organisations' perceptions regarding blockchain adoption for trusted supply chains. Given the need for trust in information authenticity and transparency, our targets are food and pharmaceutical industries. Each case study will involve semi-structured interviews, site visits, direct observations and review of organisations' archival documentations. We plan to conduct 5-6 case studies and we expect to reach theoretical saturation with this number of cases. For data analysis, open coding, axial coding and selective coding will be employed (Yin 2015). Subsequently, we will conduct a survey targeting organisations in various industries with different sizes and business types to validate the conceptual model. For data analysis, we will perform structural equation modelling (SEM) and latent variable analysis as recommended by Hoyle (1995). Upon completion, not only will our study take the body of knowledge regarding blockchain adoption for supply chain management to the next level, but it can also be used as a guidance for organisations to craft appropriate strategies in managing blockchain determinants and preparing themselves to be in a proper position that allows the establishment of trusted supply chain ecosystem.

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