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Organizational Adoption of Blockchain Technology: An Ecosystem Perspective

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Research-in-Progress

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Abstract

Organizations of all sizes are developing blockchain projects in hopes of reaping benefits from this technology. Despite rising academic interest in blockchain technology, extant research has primarily focused on technical or design challenges and improvements, with scant scholarly attention being paid to factors contributing to the adoption of blockchain technologies by organizations, which presents an opportunity for us to undertake this theory guided empirical investigation. Drawing on the Technological-Organizational-Environmental (TOE) framework and extending the framework by considering the network of actors comprising an enterprise blockchain ecosystem, we identify a set of factors most applicable to blockchain adoption and developed a research model that examines how different technological (i.e., perceived usefulness, compatibility, relative advantage, complexity, and scope of technology), organizational (i.e., top management support, organizational readiness, firm size, and firm centralization), and environmental ecosystem actors (i.e., business competition, trading partner support, technology vendor support, governmental support, and customer support) influence organizational adoption of blockchain technology. We also propose a cross-industry field survey to test our hypotheses.

Keywords: blockchain technology, TOE Framework, organizational adoption, technology ecosystem

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Introduction

Emerged as the backbone of cryptocurrencies (e.g., with Bitcoin being the most well-known), blockchain technology "is an open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way" (Iansiti and Lakhani 2017). Organizations of all sizes, including IBM, Microsoft, Walmart, JP-Morgan, Tencent, and Telefonica, have developed or developing blockchain projects in hopes of reaping benefits from this technology. Through blockchain there is greater transparency between all parties, improved traceability of each transactions, increased efficiency, security and speed, and reduced costs (Hooper 2018). According to Gartner, blockchain technology is among the top 10 strategic technology trends for 2019 and is expected to create $3.1T in business value by 2030 (Panetta 2018). However, a recent Gartner survey reveals that only 22% of CIO's responded were planning to use the technology (Suberg 2018) and a 2017 study found that 90 to 95% of organizations using blockchain were still in the pre-pilot stages (Lacity and Khan 2019). The observed discrepancy between general perception of blockchain rapidly entering the mainstream and the adoption of this technology in reality suggests the need to investigate factors influencing organizational adoption of blockchain technology.

Since Bitcoin's inception in 2008, there has been rising academic interest in blockchain technology, as exemplified by the number of special issues in major Information Systems (IS) journals and tracks in premier IS conferences devoted to the topic of blockchain. A recent literature review on blockchain research show that 80% of the existing blockchain research is on Bitcoin, with only 20% on other blockchain applications (Yli-Huumo et al. 2016). Of the scholarly work on other blockchain applications, the focus is primarily on either technical (e.g. smart contracts, transaction speeds) or design (e.g. privacy, security) challenges and improvements (Park and Yang 2018; Yli-Huumo et al. 2016). To the best of our knowledge, there has been scant research on factors contributing to the adoption of blockchain technologies by organizations, particularly from an ecosystem perspective, which presents an opportunity for us to undertake this theory guided empirical investigation.

Blockchain technology is interesting due to its potential variance in implementations. Blockchain can be implemented with permissions or without, different ways to achieve consensus, the presence or absence of coins, and the varying degree of decentralization (Lacity and Khan 2019). Blockchain technology typically spans a complex range of industries, organizations, and interests (Iansiti and Lakhani 2017), making an ecosystem perspective relevant when examining its adoption by organizations. A business ecosystem is "a commercial network of suppliers, producers, intermediaries, complementors and customers … that are held together through formal contracting and/or mutual dependency" (Muthukannan, Tan, Tan, & Leong, 2017, p. 4). Iansiti and Richards define an IT ecosystem as "the network of organizations that drives the delivery of information technology products and services" (2006). Gawer and Cusmano further note that an ecosystem must solve an important problem within an industry; it must be easy to connect to while increasing in value when more users and complementors join (2014). In this study, we define an enterprise blockchain ecosystem as the network of organizations that drive the delivery of information technology products and services through blockchain; it solves a novel business problem and increases in value when the network of organizations that use it enlarges.

From an ecosystem perspective, we aim to address the following research question in this paper: What factors drive an organization's adoption of blockchain technology? The remainder of the paper proceeds as follows. First, we review the theoretical foundation and relevant literature. Next, we present our research model and hypotheses. Finally, we outline the path forward to test our hypotheses.

Theoretical Foundation and Literature Review

In this paper, we draw on the Technological-Organizational-Environmental (TOE) framework as our theoretical foundation and extend the framework by considering the influence of the network of actors comprising the enterprise blockchain ecosystem.

The TOE framework, proposed by (DePietro et al. 1990), identifies three aspects of a firm's context that influence its innovation adoption process. The technological context includes internal/external technologies relevant to the firm, and answers such questions as what the technology encompasses, what its capabilities are, and how it is better than the firm's existing technologies. The organizational context refers to the characteristics and resources of the firm, and answers questions about the firm such as how big the firm is, what the firm's culture is, and whether adequate resources are available. The environmental context concerns characteristics of the industry, macroeconomic context, and regulatory environment, and answers questions about what the market is like, how the competition is doing, and whether there are government regulations that would impact the adoption. The TOE Framework has been used extensively in prior literature to explain the adoption of a wide range of technologies such as EDI (Kuan and Chau, 2001), internet (Mehrtens et al. 2001), cloud computing (Gangwar et al. 2015; Gupta et al. 2013), big data (Sun et al. 2018), and RFID (Kim and Garrison 2010), and has received consistent empirical support across different studies.

We believe that TOE is an appropriate informing theory for our study, because blockchain is after all an enterprise technology whose adoption is driven by technological, organizational, and environmental factors. However, a single theory is not sufficient to explain a complex interdependent technology such as a blockchain. Hence our decision to further extend the TOE by considering the influence of the network of actors (other than the focal organization) as part of its "environmental context" in an enterprise blockchain ecosystem. Each of these actors may exert positive or negative influence on an organization's adoption of blockchain technology, depending upon the actor's opinion and degree of influence on the focal organization.

Research Model

Drawing on the TOE Framework, and based on our literature review, we have identified a set of factors most applicable to blockchain adoption and developed a research model (see Figure 1) to initiate further research into organizational adoption of blockchain technology.

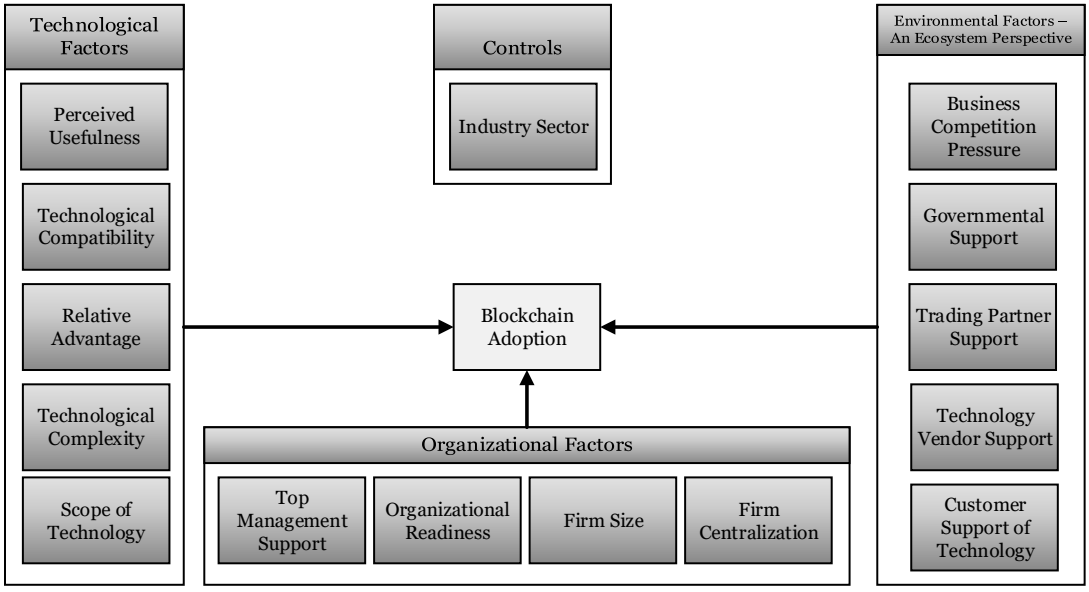

Figure 1. Research Model

Technological Factors

Perceived usefulness has been studied extensively in prior literature and has been consistently found to exert significant impact on organizational adoption on various information technologies (Chau and Tam 1997; Iacovou et al. 1995; Shah Alam 2009). An organization needs to perceive a given technology as useful to and benefiting the organization before embarking on investing in the technology. We see no reason why Blockchain would be any different. Thus, we hypothesize:

> *H1: Perceived usefulness is positively related to organizational adoption of blockchain technology.*

Technological compatibility refers to the degree to which an innovation is perceived as agreeable with existing business processes, experiences and needs of a given organization (Thong 1999). Karahanna further broke down technological compatibility into existing work practices, prior experience, values and preferred work style, finding that technological compatibility with past experiences exert most significant influence on usage (Karahanna et al. 2006). Accordingly, blockchain technology is more likely to be adopted by an organization if it fits with the organization's existing infrastructure and values. Convenience of integration and level of adjustment required to adapt the technology to the business needs also need to be taken into consideration. Thus, we hypothesize:

> *H2: Technological compatibility is positively related to organizational adoption of blockchain technology.*

Relative advantage involves the comparison of existing technologies to the proposed technology and the perceived benefits that result (Iacovou et al. 1995). The greater the degree of difference that is perceived, the greater the chance of adoption. For instance, in their investigation of e-business adoption by Chinese businesses, Li et al. (2010) showed that the relative advantage of e-business over traditional methods was a significant predictor. For blockchain, the more it is considered advantageous over an organization's existing technologies (e.g., a decentralized database), the more likely it is going to be adopted by the organization.

> *H3: Relative advantage is positively related to organizational adoption of blockchain technology*

Technological complexity refers to the degree of perceived difficulty in understanding or using the technology (Sun et al. 2018). The more complex a technology appears, the less likely it will be adopted by an organization. For instance, in a US based survey on data warehousing adoption, technological complexity was a significant predictor of adoption (Ramamurthy et al. 2008). While the implementation of blockchain technology can make it appear very similar to existing database and web entries systems, individuals may perceive the technology as complex given the hashing of blocks and long obscure addresses.

> *H4: Technological complexity is negatively related to organizational adoption of blockchain technology.*

Scope of technology is a technological factor newly developed in this study to track whether the blockchain implementation crosses an organization's internal workflow boundaries. It refers to whether a particular blockchain technology is intra- or inter-organizational, with the latter being larger in scope. Due to the many inherent risks associated with inter-organizational systems (in adoption and implementation) (Riggins and Mukhopadhyay 1999), we expect that the scope of the blockchain technology will influence its adoption by organizations.

> *H5: Scope of technology will be negatively related to organizational adoption of blockchain technology*

Organizational Factors

One of the most salient factors under organizational context is *top management support*, which refers to the involvement, support and enthusiasm by management towards the information system (Ifinedo 2011). An organization that has top management support in the adoption of an innovation is more likely to receive the resources necessary to adopt and succeed (Gangwar et al. 2015; Grandon and Pearson 2004; Sun et al. 2018). For instance, in a cross-industry survey conducted in India, top management support was a significant predictor of adoption of cloud computing (Gangwar et al. 2015). Likewise, strong support from the management is key to adoption of blockchain technology.

H6: Top Management support is positively related to adoption of blockchain technology.

Organizational readiness refers to the ability of an organization to allot resources, financial (with consideration of cost/ROI of the IS in question) and technological (i.e. level of expertise and knowledge in the IT domain (Kim and Garrison 2010)), towards a particular IS adoption (Iacovou et al. 1995). An organization that has competent IT staff to implement a planned technology and the monetary backing to absorb the risk would be in a better position to adopt an IS than one that is not. For instance, Kim and Garrison (2010) showed organizational readiness as a significant factor in RFID adoption among South Korean retailers. Likewise, we believe that the organizational readiness of a given organization will also impact the adoption of blockchain due to the financial, technological, and human resources required to implement and use the technology.

H7: Organizational readiness is positively related to adoption of blockchain technology.

Firm size, a key factor under the organizational context, is the size of a business in terms of full-time employees (Bose and Luo 2011). As firms grow larger, they may obtain employees with increasingly specialized skills and knowledge of technologies that are not presently available at the firm (Thong 1999). In a study of a large sample of German firms, firm size emerged as a strong predictor of IS adoption (Ganter and Hecker 2013). Accordingly, we also expect firm size to exert positive influence on blockchain adoption.

H8: Firm size is positively related to the adoption of blockchain technology.

Firm centralization refers to the extent to which a firm's decision making authority is centralized (Moch and Morse 1977). One of blockchain technology's key attributes is in its decentralization of information and control. A firm may find it more difficult to release control by adopting a technology whose aim is counter to its centralized authority. It has been shown in other centralized vs. decentralized encounters, that the centralized entity does not fully realize the potential of decentralization until it is too late e.g. Blockbuster refusing to buy Netflix and then upended by them (Brafman 2006). In a study of collaborative information technology, decentralized organizations were more likely to adopt and try several technologies over centralized organizations (Bajwa et al. 2005). Therefore, we hypothesize:

H9: Firm centralization is negatively related to organizational adoption of blockchain technology.

Environmental Factors – An Ecosystem Perspective

An enterprise blockchain ecosystem typically comprises of the focal organizations, competitors, trading partners, technology vendors, customers, and government. Each actor of the ecosystem plays a role in the focal organization's adoption of blockchain technology.

External pressure influencing organizational adoption of IT typically comprises two main sources of pressure: business competition pressure and trading partner pressure (Iacovou et al. 1995). *Business competitive pressure* refers to the degree to which companies compete with one another in a given industry or field over resources such as customers or market (Iacovou et al. 1995). When a business invests in an innovation, competitors may follow suit and adopt a similar innovation so as to maintain their own competitive position or take away the competitive advantage their peer may enjoy with the investment. For instance, in a study of the adoption of modern telecommunication technology of small

businesses located in rural communities in the US, competitive pressure was found to be a significant predictor of adoption (Premkumar and Roberts 1999). Likewise, we postulate that competitive pressure will exert positive influence on organizations' decision to adopt blockchain technology (with its widely publicized benefits such as transparency, traceability, security, efficiency, and cost reduction (Hooper 2018)). As competitors adopt blockchain technology, the firm may be pressured to do the same.

H10: Adoption by business competitors will have a positive influence on the adoption of blockchain technology.

While competitive pressure comes from rivals, *trading partner support* is from collaborators/partners. The value of technologies (particularly those driven by network effect) can be maximized only when many trading partners are using them (Iacovou et al. 1995). For inter-organizational information systems (e.g., EDI), powerful trading partners may exploit a combination of different influencing strategies (e.g., recommendation, promises, and threats) to pressure smaller partners into adopting such systems (Iacovou et al. 1995). As a real world example, Walmart has mandated blockchain use from its suppliers in leafy greens in order to track E.coli contaminations more effectively (Walmart 2018). Walmart is such a powerful trading partner that the suppliers must either comply or miss out in future trading. Accordingly, we hypothesize that trading partner support will positively influence organizational adoption of blockchain technology.

H11: Trading partner support is positively related to the adoption of blockchain technology.

Technology vendor support is defined as the availability of vendors to satisfy the implementation and use of a given technology (Premkumar and Roberts 1999). Technology vendors are the safety blanket for an organization in system implementation and maintenance. Cragg and King (1993) showed that regular IT consultant support led to an increased number of innovative adoptions. With blockchain being a new and complex technology, availability of vendor support will be a critical consideration in organizations' adoption decision.

H12: Technology vendor support is positively related to the adoption of blockchain technology.

Governments can influence adoption through providing related support such as legal environment, regulation and funding (Sun et al. 2018). They could also impede adoption such as China's ban of financial agencies working with cryptocurrencies (Zhang 2018). When a government implements a mandated use policy (e.g. electronic communication with the FDA) or funding (e.g. tax write-offs), organizational adoption of the IS would typically increase (Kuan and Chau 2001; Nam Jeon et al. 2006). We would expect to see similar influence of the government on blockchain adoption. Therefore, we hypothesize:

H13: Governmental support is positively related to the adoption of blockchain technology.

Customer support is also an important contributing factor in organizational adoption of blockchain technology. Blockchain allows for greater transparency and can involve customers in public instantiations of the technology. Take the IBM Food Trust with Walmart as an example: utilizing blockchain, customers are able to completely trace a head of lettuce from farm to table (Walmart 2018). Once word gets out regarding the technology's unprecedented level of transparency, it could likely lead to a vocal outcry in support of such a technology in other areas and domains. Thus, we hypothesize customer support and public request of the technology will impact adoption.

H14. Customer support is positively related to the adoption of blockchain technology.

Control Variable

Currently the financial sector and supply chain sector are experiencing rapid growth in blockchain adoption, probably due to the nature of blockchain as a transaction platform. However, other sectors (such as healthcare, government, insurance, or real estate) may also start experimenting with blockchain technology as time progresses. Thus, in this study, we include industry sector as a control variable.

Research Method

To test our hypotheses, we plan to conduct a field survey of firms within three industries most affected by blockchain technology, banking, retail, and logistics (CBInsights 2018). We will distribute our survey via email to IT decision makers (e.g., CIO's or CTO's) in a stratified sample of 100 US-based firms (to ensure the inclusion of firms of different sizes) drawn from the mailing list of each of the three industries.

Blockchain adoption will be operationalized with three different measures: (1) whether the firm has already implemented blockchain projects (Yes/No), (2, if the answer to question (1) is "yes") to what extent has the blockchain project been implemented (proof of concept, testing, phased, full operational use) and (3, if the answer to question (1) is "no") how likely it is that the firm will implement blockchain projects within two years (7-point scale from Extremely Unlikely to Extremely Likely). Scope of technology will assess whether the proposed blockchain project is inter-organizational or intra-organizational (binary). In addition, we will ask questions about the type of blockchain solution implemented, such as what type of consensus mechanism will be used, whether the technology will be permissioned or permission-less, or public or private, and what problem it is solving. We believe that due to the technology's freshness, assessing the impact of these factors may provide additional insights into organizations' adoption decision. Measurements for assessing other constructs will be adapted from prior literature.

Covariance based Structured Equation Modeling using AMOS will be employed to test both the measurement model and structural model.

Expected Contributions

In this research, we extend the TOE framework by considering the influence of the network of actors comprising enterprise blockchain ecosystem to discern factors relevant to organizational adoption of blockchain technology. We also propose a field survey of firms in different industries to validate our research model.

With rising practical and academic interest in blockchain technology, we believe that our theory-guided investigation into factors contributing to organizational adoption of blockchain is both timely and important. The findings of this research will shed light on the comparative strength of technological, organizational, and environmental factors in influencing organizations' decision to adopt (or not adopt) blockchain technology. Practically, the results of our study may guide big players like IBM, Microsoft, and Tencent to identify potential clients that may jump on the blockchain bandwagon.

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