Categorizing transaction costs outcomes under uncertainty: a blockchain perspective for government organizations

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Abstract

Purpose – In response, the purpose of this paper is to provide theoretical frameworks about the organizational uncertainty behind what and when to adopt blockchain technology and their implications on transaction costs. The immature nature and the absence of standards in blockchain technology lead to uncertainty in government organizations concerning the adoption ("what to adopt") and the identification of the right time ("when to start").

Design/methodology/approach – Using transaction cost theory and path dependency theory, this paper proposes two frameworks: to assess transaction cost risks and opportunities costs; and to depict four different types of transaction costs outcomes regarding blockchain adoption.

Findings – This paper identifies various theoretical concepts that influence blockchain adoption and combine the two critical constructs of "bounded rationality" and the "lock-in effect" to categorize the multiple transaction costs outcomes for blockchain adoption.

Research limitations/implications – Although existing research in blockchain highlights mainly the potential benefits of blockchain applications, only a little attention has been given to frameworks that categorize potential transaction costs outcomes under uncertainty, in particular from organizational theorists.

Originality/value – Both frameworks advance the understanding of the decision-making behind blockchain adoption and synthesize the current literature to offer conceptual clarity regarding the varied

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implications and outcomes linked to the uncertainty regarding transactions costs stemming from blockchain technology.

Keywords Qualitative, Transaction costs, Uncertainty, Bounded rationality, Path dependency, Blockchain, Lock-in effect

Paper type Conceptual paper

1. Introduction

Few technology applications are currently attracting as much attention as blockchain technology (Babich and Hilary, 2019; Clohessy and Acton, 2019; Herold *et al.*, 2021; Hribernik *et al.*, 2020; Iansiti and Lakhani, 2017; Queiroz *et al.*, 2019; Sternberg *et al.*, 2020; Treiblmaier, 2018). In its essence, blockchain represents a distributed, consensus-based and (mostly) immutable ledger of transaction records (Schmidt and Wagner, 2019) and is often regarded as a "game changer" (Johnson, 2018) because of its potential transformative technology. Indeed, blockchain researchers and public sector managers are not shy to point out the "enormous potential" (O'Marah, 2017) and the far-reaching implications (Friedlmaier *et al.*, 2018; Hackius and Petersen, 2017) of blockchain applications and predominantly highlight the opportunity to reduce organizations' transaction costs and increase trust with citizens (Cole *et al.*, 2019; Kouhizadeh and Sarkis, 2018; Schmidt and Wagner, 2019). For instance, the Governments of Sweden, Estonia and Georgia are planning to use blockchain-based land registries, thereby not only enabling multiple parties to securely hold copies of the registry but also to more quickly resolve property disputes and increase trust (Boeding and McConkie, 2021).

However, although government organizations acknowledge the potential of blockchain applications, management decisions regarding full blockchain adoption and implementation are still linked to uncertainties (Clavin *et al.*, 2020; Kouhizadeh *et al.*, 2020b; Mikl *et al.*, 2020). For example, Lantmäteriet in Sweden developed a blockchain-based system to digitalize the transfer of land titles in 2017, but the project was ultimately stopped due to a lack of recognizing digital signatures as well as privacy and data security issues (Kempe, 2017). In Tel Aviv, the local authorities launched the "Tel Aviv coin" to increase collaboration between citizens and the public actor in May 2019, but the project was abruptly stopped in September 2019 due to regulatory uncertainties (Lindman *et al.*, 2020).

In particular, the uncertainty for government organizations regarding blockchain technology is mainly related to the confusion about the potential benefits and underlying technology standards (Deshpande *et al.*, 2017). Public sector managers perceive the blockchain technology often as rather immature, which makes it difficult to understand how the technology operates and what the technology can actually do, in particular with regard to building blockchain-related capabilities and competencies which may result in maintaining or generating a more efficient system (Dobrovnik *et al.*, 2018; Kouhizadeh and Sarkis, 2018; Saberi *et al.*, 2019).

As a consequence, managers find it difficult to identify the right time to implement blockchain ("when to start"), as the current maturity stage is seen as "uncoordinated," where process changes are high and "fluid with loose and unsettled relationships between process elements" (Utterback and Abernathy, 1975, p. 641). In other words, managers consider blockchain technology as an early adoption risk, as investment and running costs are yet unclear and may be considerable (Kakavand *et al.*, 2017). In fact, the adoption of blockchain technology may lead to a costly redesign of existing back-office processes and complex legacy information technology (IT) systems (Deshpande *et al.*, 2017; Kouhizadeh *et al.*, 2020a). From a practical point, as most corporate blockchain applications will have to co-exist with IT legacy structures and processes, organizations may not be prepared or willing to overhaul their existing operational processes in the short- or medium-term to align the procedures with blockchain standards and protocols.

In addition, when confronted with blockchain adoption, management has to deal with unclear requirements and various blockchain designs for standards (Crosby *et al.*, 2016), thus facing uncertainty "what to adopt." To date, many diverse blockchain "products" exist competing with each other to develop standards and protocols (Deshpande *et al.*, 2017; Huillet, 2020). Specifically, in lack of a mutually agreed blockchain standard or a "dominant design" (Argyres *et al.*, 2015; Utterback and Abernathy, 1975), organizations either have to adopt industry-specific operational and technical management practices (in which they may have no say) or invest heavily in developing standards to achieve wider industry acceptance (Shackelford and Myers, 2017). This uncertainty with regards to blockchain adaption may lead to a disagreement over mutual industry standards which could make it difficult for ledgers to exchange information with other ledgers and legacy IT systems (Mills *et al.*, 2016). Thus, instead of having "one big" blockchain, industries may have to deal with dozens of fragmented blockchain systems competing with each other or even may end up with thousands of ledgers (De Meijer, 2016).

From a theoretical point of view, the uncertainty concerning blockchain adoption and the identification of the right timing can be attributed to uncertainty about the implications on transactions costs. Although most blockchain literature claims that blockchain technology has the potential to significantly reduce transactions costs (Cole *et al.*, 2019; Kouhizadeh and Sarkis, 2018; Kummer *et al.*, 2020; Schmidt and Wagner, 2019), a potential transaction cost advantage still depends on the decision what blockchain standard to adopt ("what to adopt") and the identification of the right time ("when to start").

In particular, the decision of what blockchain standard to adopt is linked to the contextual uncertainty and the associated *bounded rationality* (Simon, 1972, 1997). Bounded rationality comprises the idea of the practical impossibility of perfect decisions as it takes into account the cognitive limitations of the decision-maker – limitations of both knowledge and computational capacity (Simon, 1990). Thus, in contrast, to assume that human decisions are based on rational choice, bounded rationality argues that decision-makers trying to maximize their output by "satisficing" (a combination of satisfy and suffice, see Fu and Gray, 2006; Sanders and Carpenter, 2003), i.e. they search for alternatives that are good enough according to some pre-established criteria (Barros, 2010; Dequech, 2001). In institutional environments such as in government organizations, the decision of what blockchain standard to adopt is thus surrounded by uncertainty and may represent only a satisfactory alternative design, which may also increase the risk for higher transactions costs (Tegarden *et al.*, 1999; Yiu and Makino, 2002).

A decision regarding the timing of the blockchain implementation for a potential transaction cost advantage can be linked to the *lock-in effect* (Bahli and Rivard, 2003; Narula, 2002). The lock-in effect, a construct within path dependency theory (Aylward, 2006; Barnes *et al.*, 2004), can be regarded as a byproduct of "organizational inertia" (Kelly and Amburgey, 1991) when organizations follow conservative pathways to limit various forms of risk. In other words, due to institutional linkages, internal dynamics, hierarchical and operational legitimacy or structural arrangements, organizations may "lock-in" a certain path (and associated practices) irrespective of whether the decision is an optimal one (Bittick, 2008; Suarez *et al.*, 2015). In the context of blockchain implementation, path dependency theory would argue not only that organizations may stick with a certain "path" or a certain blockchain standard due to institutional norms and arrangements, but that the "lock-in" effect makes it very difficult to change the standard once it has taken hold, even if alternatives may be more efficient. For a blockchain standard, where "a dominant design has not yet stabilized" (Geels, 2004, p. 37), deciding on a certain standard is associated with risks and uncertainty, as the chosen path may not align with the future dominant design, thus risking higher transaction costs.

Given this uncertainty around the adoption and implementation of blockchain technology, there is a need to examine its determinants and clarify its implications on transaction costs. In particular, the role of uncertainty regarding bounded rationality and the lock-in effect in the decision-making of what and when to adopt blockchain technology remains to be explored. We specifically set the following research questions:

RQ1. How does the uncertainty regarding blockchain adoption influence transaction cost risks and opportunities?

RQ1a. How does uncertainty under bounded rationality influence transaction costs regarding blockchain adoption?

RQ1b. How does uncertainty under the "lock-in effect" influence transaction costs regarding blockchain implementation?

RQ1c. How does the interplay between bounded rationality and the lock-in effect influence transaction costs?

In this paper, we theorize about the organizational uncertainty behind what and when to adopt blockchain technology stemming from bounded rationality and the lock-in effect and their implications on transaction costs. The aim of this paper is twofold. First, this study will illustrate how bounded rationality and the lock-in effect cannot only influence management decisions to adopt blockchain technology but also its implications on transactions costs. To do so, we integrate transaction costs theory with path dependency theory and consolidate the critical concepts of both theories into a transaction cost framework that presents the influences on transaction costs with regard to blockchain adoption. We argue that transaction cost theory alone is limited to categorizing the risks and opportunities for blockchain adoption, and the inclusion of path dependency theory provides a theoretical foundation to complement transaction cost theory to categorize these transaction cost risks and opportunities.

Second, we use the main concepts in the framework to build an integrative model that depicts four types of transaction costs outcomes for blockchain adoption. Although scholars and managers acknowledge the potential of blockchain technology to build a competitive advantage, its implications on transaction costs and the associated risks and opportunities to adopt blockchain technology remain unanswered. This inherent uncertainty makes it difficult for an organization to decide what blockchain standard to adopt and identify the right timing for blockchain implementation. We combine two critical dimensions in transaction costs theory and path dependency theory to categorize transaction cost risks and opportunities. The first dimension represents "bounded rationality" constraints when making decisions, which in the context of our study, reflects the degree of uncertainty with regard to what blockchain standard should be adopted. The second dimension represents the "lock-in effect," which is defined in the context of our study as the degree of uncertainty when blockchain technology should be implemented.

By expanding insight into the concepts and implications stemming from the uncertainty behind what and when to adopt blockchain technology, this paper makes several important contributions to the literature. First, we present a conceptual model, which proposes that transaction cost theory and path dependency provide a theoretical foundation that can be used to examine the transaction cost risks and opportunities for blockchain adoption. This model thereby links the uncertainty behind *what* blockchain standard to adopt with the uncertainty of *when* blockchain technology should be implemented to better understand their implications on transaction costs. Second, by categorizing the transaction costs behind blockchain adoption in terms of bounded rationality and the lock-in effect, our model proposes four types of transaction cost outcomes, thus providing an understanding of the different transaction cost risks and opportunities. This study thereby addresses the inherent uncertainty associated with the decision-making and provides clarity about the transaction cost implications.

Third, the combination and interplay of these concepts allow the identification and categorization of the various implications on transaction costs to gain an understanding of the varied risk and opportunities of blockchain technology. In this regard, the framework advances the growing body on the implications of blockchain technology, which to date has been limited in providing an explanation of the lock-in effect on blockchain technology implementation. Finally, by categorizing transaction costs, risks and opportunities, our framework points to practices through which management can exert influence on blockchain adoption decisions. In this respect, we provide important insights into how bounded rationality and the lock-in effect lead to specific transaction costs outcomes, and we further develop research on blockchain technology by exploring how organizations can reduce uncertainty.

This paper is structured as follows: Section 2 introduces a framework that clarifies the role of blockchain standards and discusses critical assumptions for this research. Section 3 deals with the role of transaction costs in blockchain adoption. In particular, this section discusses the uncertainty related to blockchain management decisions and their implications on transaction costs. Section 3.1 introduces the first key dimension in categorizing transaction cost outcomes: bounded rationality. The contextual uncertainty inherent in bounded rationality will help us to understand why not always a dominant design may be chosen and explain the impact on transaction costs. Section 3.2 introduces path dependency and the second key dimension to categorize transaction costs outcomes: the lock-in effect. A combination of these two key dimensions is illustrated in Section 4, where four types of transaction cost outcomes are described and presented in a model. Conclusion highlighting the contributions of this paper and discussion of future research is given in Section 5.

2. The assumptions of the transaction costs framework

In this section, we present our transaction costs framework and the assumptions that link uncertainties stemming from bounded rationality and the lock-in effect to illustrate the transaction costs risks and opportunities of these uncertainties regarding blockchain adoption (Figure 1). Transaction costs can be defined as overall costs incurred in making an economic exchange, including, for example, the costs of gathering information, contracting, negotiating and evaluating alternative options (Nilsson and Sundqvist, 2007; Shahab and Allam, 2020). In the context of blockchain, a transaction cost risk would occur when decision-makers early adopt a standard that has a slim chance to become the industry standard. In contrast, early adoption of a blockchain standard that becomes the industry standard can be regarded as a transaction cost opportunity. As such, of particular importance for this paper is the role of a mutually agreed standard for blockchain technology (Anderson and Tushman, 1990; Sahal, 1981), which represents a *dominant design* and can be defined "as a single architecture that becomes widely accepted as the industry standard" (Tegarden *et al.*, 1999, p. 496). For example, in the transport and logistics sector, FedEx, UPS and DHL, the dominating global express transport providers, are part of the "Blockchain in Transportation Alliance (BiTA)" to develop a single standard that can be used in the entire logistics and supply chain industry (Tate, 2019). Organizations want to choose the dominant design not only because accepting the industry standard reduces the uncertainty associated

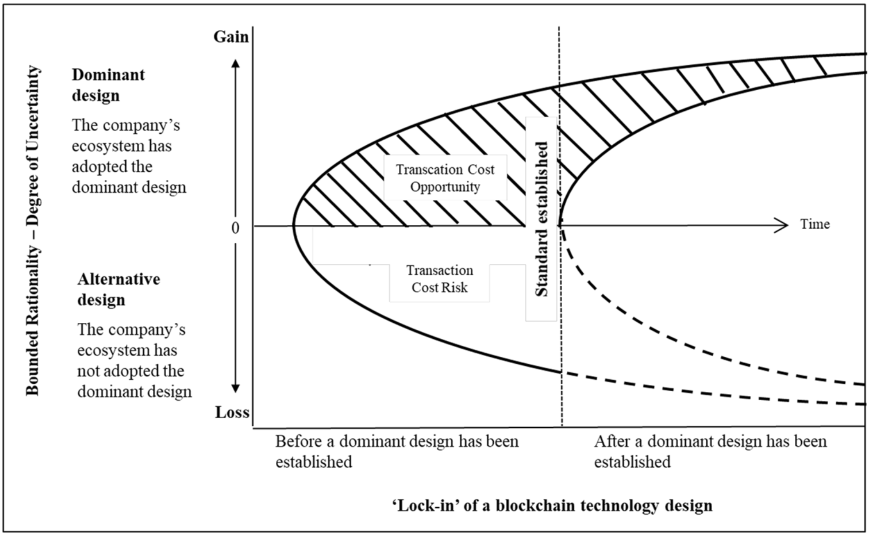

Figure 1. Transaction costs risks and opportunities for blockchain adoption

with technological discontinuity but also because a "bandwagon" of organizations, customers and suppliers will eventually adopt it as the expected pay-offs are higher (Wade, 1995). However, the path or "the ability to predict which design will win is an uncertain process" (Tegarden *et al.*, 1999, p. 496). In other words, which design will eventually emerge to be the dominant design is rarely apparent early in the development of new technology advancement.

This description of blockchain standard or a dominant design leads to four assumptions that are crucial to our framework. First, we assume that a blockchain standard or a dominant design has not been established so far; thus, it is still uncertain which design will become an industry standard. To date, organizations and organizations have developed their own blockchain "products" with different standards and competing with each other to establish a dominant design (Deshpande *et al.*, 2017; Huillet, 2020). Second, we assume that the industry's ecosystem has not locked in any blockchain standard, be it the dominant design or an alternative design. Given the uncertainty around blockchain applications, the "bandwagon" of organizations, suppliers and customers (Wade, 1995) has not decided yet which design to follow.

Third, we assume that the industry demands one mutual blockchain standard – that is, to function properly, organizations and organizations will eventually jump on the "right" bandwagon (Suarez *et al.*, 2015) and abandon other designs (Anderson and Tushman, 1990; Sahal, 1981). Fourth, we assume that if blockchain technology is implemented, it shows a better transaction costs performance than legacy systems. We thereby follow the majority of scholars that point out the positive performance with regard to transaction costs and highlight a potential transaction cost advantage (Clohessy and Acton, 2019; Dobrovnik *et al.*, 2018; Iansiti and Lakhani, 2017; Queiroz *et al.*, 2019; Treiblmaier, 2018).

3. Blockchain adoption and its transaction costs implications

So far, blockchain research predominantly highlights the opportunities of blockchain applications and their potential to reduce transaction costs. The relationship between transaction costs and blockchain has attracted a lot of scholarly research (Ghode *et al.*, 2020;

Nowiński and Kozma, 2017; Roeck *et al.*, 2019; Schmidt and Wagner, 2019; Sousa *et al.*, 2020; Tapscott and Tapscott, 2017), but current literature lacks still frameworks that can help to describe the impact of blockchain adaption and its implementation on transaction costs. In particular, existing research is limited to illustrating the blockchain adoption and implementation risks and opportunities regarding transaction costs.

In an attempt to fill that gap, we will provide a framework that considers the uncertainties behind blockchain adoption and its implementation and illustrates its impact on transaction costs. In this study, we apply transaction cost theory to a blockchain environment to investigate the impact of decisions under uncertainty. Transaction cost theory is an ideal construct to examine blockchain technology as blockchain is essentially a ledger of transactions, so blockchain and transaction costs theory show a significant overlap (Notheisen *et al.*, 2017; Schmidt and Wagner, 2019). Transactions costs occur through the constant need to gather and process information, draft and (re-)negotiate contracts and arrangements, monitor and enforce agreements as well as manage and maintain relationships within these transactions (Dyer, 1997; Rindfleisch and Heide, 1997). In other words, the unit of analysis in a transaction is understood as an exchange of information, goods or services between value-adding stages within a firm (Williamson, 1975, 1979).

In a blockchain context, decision-makers see blockchain still as an early adoption risk (Kakavand *et al.*, 2017), and managers are confronted with uncertainty, i.e. "unanticipated changes in circumstances surrounding a transaction" (Grover and Malhotra, 2003, p. 460), about the potential benefits and underlying blockchain technology standards (Deshpande *et al.*, 2017) and its impact on transaction costs (Schmidt and Wagner, 2019). In particular, this immature nature and the absence of standards in blockchain technology leads to uncertainty in organizations concerning the adoption ("what to adopt") and the identification of the right time ("when to start"). In the following sections, we will discuss these uncertainties that decision-makers have to consider and provide the potential impact of blockchain adoption and implementation on transaction costs.

3.1 What to adopt? Uncertainty under bounded rationality

Literature suggests that decision-making is often associated with contextual uncertainty (Yiu and Makino, 2002) and the associated "bounded rationality" (Simon, 1957, 1990), which reflects the idea that managers and organizations aim to make rational decisions, but the decision makers' capability is restricted by imperfect information and is thus "cognitively constrained" (Fiske and Taylor, 1991) to collect, interpret and process new knowledge. Organizations often have conflicting goals and decision-makers, in the absence of full information, have often choose alternatives or create a process to generate alternatives to fulfill the organization's goals. It is argued that these conflicting goals and the decision-makers' limitations eventually lead to a so-called "satisficing" strategy rather than an optimal one (Dequech, 2001); thus, the decision-maker may choose an alternative that is "good enough," but not necessarily the best. As Simon (1957, p. 24) argues, decision-making under bounded rationality is "intendedly rational, but only limited so."

The implications of bounded rationality in the context of blockchain technology have consequences when decision-makers need to engage with the question "what to adopt." In the context of our study, bounded rationality reflects the degree of uncertainty regarding what blockchain standard should be adopted. Not all alternatives are previously handed to the decision-maker, and not all information may be available; thus, the choice of which standard to adopt may be subject to a "satisficing" alternative. In other words, decision-makers or organizations, when presented with the choice of multiple blockchain standards, may engage in "satisficing" and choose not to adopt the dominant design but an alternative design. The reasons to choose only a satisficing alternative are related to either environmental or behavioral uncertainty (Schmidt and Wagner, 2019). For example, institutional pressures such as dependencies from powerful industry-specific entities may lead to political or industry-driven decisions that do not necessarily represent the best alternative (Cohen *et al.*, 2019; DiMaggio and Powell, 1983, 2004). Or in early stages, if one key participant in the organization's ecosystem has already adopted the alternative standard, other participants follow the "first adopter," and the standard is eventually embedded in the organization's ecosystem (Caplan and Boyd, 2018; Heuer, 2011; Zacharakis *et al.*, 2003).

The choice to adopt the dominant design or an alternative design, however, has implications on the transaction costs (Barros, 2010; Schmidt and Wagner, 2019; Yiu and Makino, 2002). Transaction costs include so-called coordination costs and contractual costs (Grover and Malhotra, 2003; Williamson, 1979), which are of particular interest in the context of our research. Coordination costs include costs for information exchange and the executed decision-process to manage the flow of services and synchronize its activities within its ecosystem (Clemons *et al.*, 1993), whereas contractual costs refer to the costs of writing, monitoring and enforcing a contract, including its associated organizational practices, processes and structures that need to be set up and maintained (Benslimane *et al.*, 2005; Chen *et al.*, 2017).

Scholars found that these transaction costs can be significant in high-technology contexts, particularly when discussing technology standards due to a need e.g. for extensive knowledge transfer, requirements specification and system design (Argyres and Mayer, 2007; Argyres *et al.*, 2007; Benaroch *et al.*, 2016; Dibbem *et al.*, 2005). As a consequence, the choice of which standard or design to adopt has implications on transaction costs. For example, if an organization adopts an alternative design, future transaction costs may increase when the organization eventually has to "switch" to the dominant design, as the process of coordination needs to be initiated again, and the former coordination efforts were pointless. In contrast, if an organization adopts a dominant design, it reduces the uncertainty regarding future coordination costs as the newly implemented practices and the process can be kept, and no new coordination efforts need to be initiated. Thus, choosing a dominant design has positive effects on transaction costs, whereas choosing an alternative design increases uncertainty and may lead to an increase in transaction costs.

3.2 When to start? Uncertainty and the "lock-in" effect

The decision to implement blockchain technology is difficult when the realization of benefits is uncertain. As a response to this uncertainty, organizations often resort to a mechanism with path dependency, the so-called "lock-in" effect. The argument behind the "lock-in" effect is that organizations become victims of their own success, i.e. once an organization has created a successful pathway, organizational practices make the organization hesitant to experiment elsewhere (Pierson, 2000). In other words, established structures, mechanisms and practices have created pathways that have become institutionalized (Aylward, 2006), i.e. through continued use and acceptance within the organization, the pathway has created its own legitimacy and deviating from it is seen as problematic (Hannan and Freeman, 1984).

In a blockchain implementation context, it means that independently from whether the dominant or the alternative design is adopted, the choice becomes "locked-in" due to reasons such as the initial large set-up costs involved, learning effects or coordination effects. Thus, the "lock-in effect" represents the degree of uncertainty *when* blockchain technology should be implemented. In general, organizations will either implement a standard prior to the establishment, and if required, change to the dominant design or wait with the implementation until a dominant design has emerged (Tegarden *et al.*, 1999). That is, because an early choice is associated with certain risks: Scholars found that often initial design choices made by organizations do not emerge as dominating design and are for the most part abandoned (Anderson and Tushman, 1990; Park *et al.*, 2018). Organizations that implement a certain standard prior to the emergence of a dominant design usually reduce their investment, being aware that the chances are high that their choice will not represent the dominant design (Tegarden *et al.*, 1999; Utterback and Abernathy, 1975).

Path dependency theory would argue that implementing a certain blockchain standard, whether dominant or alternative, can be self-reinforcing, which leads to a positive-feedback loop: the more people that adopt the blockchain standard, the more attractive it is for further adoption. Although this might be good if a dominant design has been chosen, the "lock-in" effect may also lead to negative externalities, inertia, e.g. if a particular technology is adopted, that choice decreases the value of another competing technology and its chance of adoption (David, 1985). In other words, positive feedback and negative externalities lead to a particular path, where the self-reinforcing excludes other possibilities in the future, creating inertia of the lock-in effect.

As a consequence, the lock-in effect has implications that decision-makers need to consider *when* to implement blockchain technology. If an organization decides to implement a certain standard before a dominant design has been established, it may choose an alternative design and needs to switch eventually to the dominant design, which incurs incremental costs. However, if decision-makers implement earlier a standard that becomes the dominant design, it may result in first-mover advantages (Gomez *et al.*, 2016; Lieberman and Montgomery, 1988). In other words, if decision-makers choose the dominant design before it emerges, it leads to a competitive advantage as waiting competitors will invest only when a dominant design has been established and thus may experience a significant delay in reducing the transaction costs. On the other hand, waiting until the dominant design has emerged reduces uncertainty and subsequent risk to invest and implement the wrong standard.

4. Types of blockchain strategies under uncertainty

Taken together, the uncertainties related to "bounded rationality" and to the "lock-in" effect provide a theoretical foundation to build an integrative model which allows to categorize blockchain strategies. In the context of our study, we argue that bounded rationality reflects the degree of uncertainty regarding *what* blockchain standard should be adopted, whereas the "lock-in effect" represents the degree of uncertainty *when* blockchain technology should be implemented. To establish a clear distinction between those uncertainties in the context of our study, bounded rationality comprises the uncertainty of whether the dominant design or an alternative design is adopted, i.e. whether the organization and its ecosystem decide to follow the industry standard or decide to follow an alternative design with the related risks. The "lock-in" effect represents the timing of blockchain implementation, i.e. whether the organization decides to implement blockchain technology before a dominant design has been established (to potentially gain a competitive advantage) or implement blockchain after a standard has been established (to avoid risks).

In this section, we combine these uncertainties to propose four types of blockchain strategies: harvest, build, adapt and legitimize. Figure 2 depicts the four types of strategies, and each type is described.

4.1 Strategy: harvest

The first type of blockchain strategy represents the scenario where the organization has adopted the dominant design and has started the implementation before the industry standard has emerged. In these organizations, the adoption of the dominant design shows reduced uncertainty and a subsequent adoption within the organization's ecosystem. An implementation before the dominant design has been established indicates a deliberate

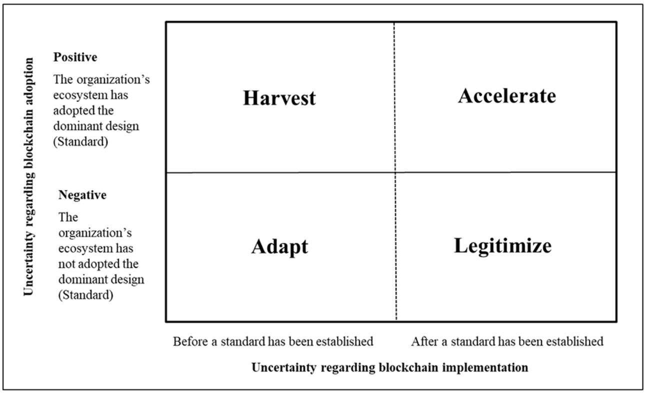

Figure 2.
Types of blockchain strategies under uncertainty

decision under reduced uncertainty to achieve a competitive advantage over the waiting competitors to use reduced transaction costs to either reduce prices or increase margins. We, therefore, label this type *Harvest*.

Organizations that follow a harvest strategy are usually organizations that have incorporated a strong focus on strategic long-term planning in their operations. From a blockchain standard perspective, organizations and decision-makers have invested heavily in R&D and watched market developments closely with regard to technological advancements (Herrmann, 2005). For example, the state of Georgia was one of the first movers toward blockchain-enabled land registries in 2016, enabling seamless integration with preexisting property registries, thereby heavily reducing transactions costs and completion of transfers in days rather than months (Eder, 2019). In particular, organizations that can "reap the fruits" have worked on several strategic maneuvers that can be deployed to capture the market, and it has planned its access to complementary assets in the ecosystem to exploit the dominant design (Fernández and Valle, 2019). Organizations in this quadrant, however, could also be decision-makers involved in the development of blockchain industry standards, thus having acquired knowledge about the technology and the market that reduces the uncertainty to choose an alternative standard that will not become the dominant design (Rohrbeck and Kum, 2018; Ruff, 2006).

4.2 Strategy: accelerate

The second type of blockchain strategy represents the scenario where the organization has adopted the dominant design but has waited with the implementation until industry was established. In contrast to the *Harvest* type, uncertainty in these organizations seems to be a prevalent characteristic with regard to the timing of a blockchain technology implementation and blockchain adoption. Moreover, Flood and McCullagh (2020) argue that the blockchain community within its decentralized community is not able to create consensus, and thus, the formation of standards is particularly difficult to achieve. As a consequence, the waiting period until a standard has been established indicates that organizations in that quadrant deliberately delayed their decisions to reduce risks and uncertainty but are ready to implement blockchain to catch up with their competitors. We, therefore, label this type *Accelerate*.

To catch up with their competitors, these organizations need to build dynamic capabilities of adaption and innovation (Koberg, 1987). To accelerate, these organizations need to prepare themselves for a transformation to use blockchain technology on two capability levels. First, these organizations have to build adaption capabilities to not only exploit and shift resources supported by acquiring and dissemination of existing knowledge but also through resource reconfiguration, divestment and integration (Dixon *et al.*, 2014; Sánchez *et al.*, 2011). In addition, these organizations need to build innovation capabilities through exploration supported by experimentation, risk taking and the introduction of related internal practices (Dixon *et al.*, 2014; Strandholm *et al.*, 2004). These dynamic capabilities will enable organizations to accelerate the roll-out and the efforts to leverage and enhance blockchain practices.

4.3 Strategy: adapt

The third type of blockchain strategy represents the scenario where the organization has adopted an alternative design and has started the implementation before the industry standard has emerged. Uncertainty in these organizations seems to be related mostly to the adoption aspect; thus, these organizations have either unintentionally decided against the dominant design or deliberately chosen an alternative design due to institutional or stakeholder pressures. As a response to this uncertainty, these organizations should be flexible enough to react to suboptimal outcomes. We, therefore, label this type *Adapt*.

Organizations with adaptive strategies need to develop a degree of internal resilience when operating under uncertainty. Resilience occurs as a result of the development and the execution of both operational and strategic capabilities; thus, these organizations should prioritize their capabilities to achieve a level of "strategic readiness" (Ismail *et al.*, 2011). Instead of being limited to acting in a responsiveness mode, the agility concept encourages pro-activeness to develop capabilities that increase the resilience within the organization (Cervone, 2014). In a blockchain environment where an alternative design has been adopted, achieving this resilience is challenging. Existing research argues that when an alternative design has been implemented, cross-organizational processes, i.e. collaborative work practices and structures required to realize blockchain technology, become institutionalized, thus making it hard to change the design (Hylving *et al.*, 2012). For example, The Netherlands uses a blockchain-based infrastructure to administer its pension program (Allessie *et al.*, 2019), but in the beginning, it was based on bilateral connections between the pension funds, governmental and private sector systems (which implies continuous copying of data between the databases). As a consequence, given the inherent uncertainty associated with blockchain and standards, organizations in this quadrant should not only prioritize their capabilities based on the most likely growth scenario but should evaluate other possible scenarios, thereby building on their unique capabilities while developing a degree to exploit other scenarios (Akgün and Keskin, 2014; Eisenhardt and Tabrizi, 1995; Ismail *et al.*, 2011).

4.4 Strategy: legitimize

The fourth type of blockchain strategy represents the scenario where the organization has adopted and implemented an alternative design when a different but dominant system has already emerged. Given the multiple risks associated with this decision, the rationale behind that decision can be attributed to the organizational challenges (Benner, 2010; Tushman and Anderson, 1986) such as management cognitions (Tripsas and Gavetti, 2000), absorptive capacity (Cohen and Levinthal, 1990), path dependency (David, 1985), myopic learning (Levinthal and March, 1993), strong identity (Tripsas, 2009) as well as external and internal institutional pressures (Herold *et al.*, 2019). For example, the above-mentioned example of the "Tel Aviv coin" was a failure that can be attributed to a lack of understanding of the immediate business environment and its standards (Lindman *et al.*, 2020). However, as a consequence, the adoption of an alternative standard that not follows an existing dominant design is what Dougherty and Heller (1994, p. 202) call "illegitimate" activities as they violate prevailing practice. As a response, the organization needs to demonstrate to internal and external stakeholders that they are willing to close this legitimacy gap. We, therefore, label this type *legitimize*.

Organizations that need to regain legitimacy may do this in two ways in a blockchain standard context: link the existing technology with the dominant design or restructure the process with external help. In particular, decision-makers may link technologies and standards by drawing on established technological conceptualizations, link departments by relying on existing roles and integrate the dominant design by following the usual chain of command (Bunduchi, 2017; Dougherty and Heller, 1994). In contrast and when confronting institutional pressure that hinders a switch to the dominant design, decision-makers may hire external consultants (e.g. technology experts) that have capabilities beyond the normal knowledge managing practices used by the organization (Schiavone, 2011).

5. Conclusion

If bounded rationality and lock-in effect have impacts on blockchain decisions, then frameworks that describe these impacts expand insight into the concepts and implications and thus advance management research. Management decisions regarding blockchain adoption and implementation are still linked to uncertainties about the potential benefits as well as the underlying technology standards. This paper's intention was to clarify these uncertainties and build frameworks that help to describe the implications regarding the adoption ("what to adopt") and the implementation ("when to adopt") of blockchain technology and standards. To provide insight into the nature of these impacts, we developed two frameworks. The first framework showed that the trajectories and their implications on transaction costs of decisions under uncertainty. We proposed bounded rationality and the lock-in effect as the two dimensions to display these implications and clarified the conceptual and theoretical elements and processes. To propose concrete management outcomes for decision-makers to deal with the uncertainties, we build an integrative model consisting of four quadrants that depicted four types of blockchain strategies.

As such, our frameworks make several contributions to the literature on transaction costs and the associated inherent uncertainty for decision-makers. First, we presented a conceptual model that linked the uncertainty behind *what* blockchain standard to adopt with the uncertainty of *when* blockchain technology should be implemented to better understand their implications on transaction costs. Second, by categorizing the transaction costs behind blockchain adoption in terms of bounded rationality and the lock-in effect, our model proposes four types of transaction cost outcomes, thus providing an understanding of the different transaction cost risks and opportunities. This study thereby addressed the inherent uncertainty associated with the decision-making and provides clarity about the transaction cost implications. Third, the combination and the interplay of these concepts allow the identification and categorization of the various implications on transaction costs and points to practices through which management can exert influence on blockchain adoption decisions. In this respect, we provide important insights into how bounded rationality and the lock-in effect lead to specific transaction costs outcomes, and we further develop research on blockchain technology by exploring how organizations can reduce uncertainty.

The results have to be viewed in light of the model limitations. Although our model and the associated uncertainties may be applied beyond blockchain applications and thus in a greater technological innovation context, the blockchain case reflects a specific case as scholars see industry-changing potential in this technology. Moreover, we reduced the uncertainties to bounded rationality and the lock-in effect, but other uncertainties exist in practice; thus, our discussion of the literature and theories is not exhaustive. Although this approach may be regarded as cherry-picking approach, we chose these specific constructs to provide a theoretical underpinning for the blockchain adoption and implementation challenges in government and organizations and thus to provide a comprehensive framework that can spark discussions from both a managerial and scientific viewpoint. We encourage future researchers to extend our framework by integrating other factors, in particular regarding institutional and stakeholder pressure, that can influence management decisions. Overall, it seems that blockchain research that includes and integrates organizational theories to explain the phenomena is still in its infancy. Future research will help to understand how these uncertainties impact blockchain and other technological innovation in an organizational context.

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