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ScienceDirect

Procedia Computer Science 181 (2021) 664–670

Procedia Computer Science

www.elsevier.com/locate/procedia

CENTERIS - International Conference on ENTERprise Information Systems / ProjMAN - International Conference on Project MANagement / HCist - International Conference on Health and Social Care Information Systems and Technologies 2020

Determinants of Blockchain Technology Introduction in Organizations: an Empirical Study among Experienced Practitioners

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Abstract

Blockchain is expected to enable new types of interorganizational relationships, new approaches to governance and new approaches to settlement and clearing processes. Neverthless, although the interest on blockchain is on the rise, there are not many blockchain implementations in organizations and there is limited empirical research investigating the reasons for this. This paper contributes to filling this gap by investigating the following research question: what are the impeding and motivating factors for organizational blockchain adoption? Data were collected through a survey based on pairwise comparisons of key factors identified in the literature. The data collected were analyzed using the Analytical Hierarchy Process (AHP) which is a structured approach for deriving priorities among diverse elements. The results provide insights about the issues that matter the most for practitioners and show that infrastructural qualities (reliability, transparency, immutability) matter more than characteristics related to blockchain´s transformative potential (automation of transactions, decentralization). Furthermore, the results for impeding factors indicate that the most prominent concerns relate to maturity and scalability.

Keywords: blockchain; implementation; Analytical Hierarchy Process; infrastructure; innovation

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10.1016/j.procs.2021.01.216

1. Introduction

Blockchain is a technology that supports tamper-resistant and transparent transaction recording. A blockchain serves as a distributed database which maintains records secured by cryptography, and governed by a consensus algorithm [1, 2]. It can be used for decentralized record-keeping and transaction documentation minimizing counterparty and settlement risks. Blockchain is expected to enable new types of interorganizational relationships, new approaches to governance and new approaches to trading, settlement and clearing processes [3, 4]. Neverthless, although the interest on blockchain is on the rise, there are not many blockchain implementations in organizations. Implementing a new infrastructural technology is risky and demanding as it frequently requires eradicating existing arrangements, introducing new competencies and ensuring reliability, availability, and flexibility within complex digital ecologies [5-7].

There is a significant growth in blockchain-related research, but most of it is focused on technical and high-level governance aspects and tends to ignore the practical issues that relate to blockchain introduction into organizations [8]. Hence, literature on blockchain architectures tends to be positioned either within technical or strategic discourse [9]. There is limited research aiming to bridge the gap between blockchain potentialities and practice. In particular, there is limited research oriented towards issues of blockchain adoption and applied business value creation [2] and researchers interested on blockchain introduction within organizations have few scholarly studies to rely on. Our study aims to fill this gap by answering the following research question: what are the impeding and motivating factors for organizational blockchain adoption?

Specifically, we performed an empirical study among experienced practitioners inquiring about the determinants of blockchain technology introduction in organizations. For the data collection, we designed a survey with pairwise comparisons of key factors identified in the literature, and analyzed our data using the Analytical Hierarchy Process (AHP) which is a structured approach for deriving priorities among diverse elements [10]. The application of AHP gave us insights about the issues that matter the most for practitioners. The study findings show that the infrastructural nature of blockchain technology needs to be taken into account for understanding organizational adoption. Implementing a new infrastructural technology is risky and demanding. Ensuring dependability is key, especially in the cases where infrastructural renewal entails eradicating existing arrangements. Hence, factors related to trust in this technology are critical. The empirical results show that expectations of reliability, immutability and transparency are driving blockchain initiatives while concerns about the technical maturity of blockchain solutions impede the introduction of blockchain in organizations.

The paper has implications both for theory and practice. On the theoretical level, we expose the impact of different types of technology characteristics on the introduction of novel infrastructural technologies within organizations. Our findings show that the transformative potential of blockchain technology (to decentralize and to automate through smart contracts) is not as valued by professionals as much as trust related charactrestics. As a contribution to practice we provide insights about motivations and concerns that can be helpful for those facilitating blockchain introduction.

The remainder of the paper is organized as follows. Section 2 presents the method used for collecting and analyzing the data for this study. In Section 3, we present the findings from the literature review and in Section 4, we present the empirical findings. Finally, in Section 5 we discuss and conclude by identifying directions for further research.

2. Method

The study was performed in three major steps: a) literature review and construction of an AHP model, b) empirical data collection, c) empirical data analysis. The literature review was guided by the guidelines suggested by Kitchenham [11] for planning (developing a procedure for conducting the review), implementing (identifying previous research, selecting the main studies, undertaking quality assurance of the studies, collecting, synthesizing the studies), and reporting and assessing the results. The review results led to the identification of several factors impeding or motivating the introduction of blockchain in organizations. These factors were used for building an AHP model. AHP is a method suited for providing insights on the relative importance of different attributes on a particular outcome and simplifies priorities using pairwise comparisons [10, 12, 13]. We used AHP to derive knowledge about the importance of determinants of blockchain technology by reaching out to professionals, collecting their judgments about factors found in the literature and synthesizing them.

For the empirical data collection part, the most critical activity was the identification of practitioners that have been engaged in blockchain initiatives or are currently considering introducing blockchain applications in their

organizations. They were identified through conferences and events, business networks and clusters as well as through personal professional networks and LinkedIn. The empirical data collection was performed in 2019 in Norway. Relevant participants for the study were sought in the events: Software 2019, The digital conference, Oslo Blockchain Day, Southern Norway's oil and energy conference, Practical use of blockchain technology event, Smart health digital conference amd also through the chamber of commerce in Kristiansand, Digin - The ICT cluster of southern Norway, Blockchangers community (slack and Facebook) and Norway's Bitcoin and Blockchain association. There is a limited number of practitioners with actual blockchain experiences and it was difficult to identify and enroll them in the study. Overall, 405 potential participants were contacted, 72 of them were found to be relevant and eventually, 29 participants with blockchain experience provided complete answers to the AHP-based survey.

The survey required from the respondents to provide input, regarding the importance of each factor identified in the literature, in comparison to the importance of another factor of the same category. For the pairwise comparisons a standard scale ranging from 1 to 9 was used (where "1" indicates equal importance among two factors and "9" indicates that one of two factors is extremely more important than the other). The respondents were asked to provide their input by placing a slider within each factor pair (see figure 1 for a sample of the survey instrument used).

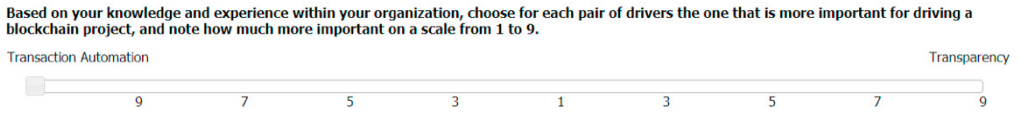

Fig. 1. Sample from the AHP survey instrument used

To analyze the data collected, the spreadsheet developed by Goepel [14] was used to calculate the factor rankings per participant by consolidating the priorities indicated in pairwise comparisons. The aggregation of several respondent judgements in AHP is commonly done using one of two methods: the aggregation of individual judgmen ts (AIJ) and the aggregation of individual priorities (AIP) [10]. The choice of method is based on whether the respondents are assumed to be part of a synergistic unit or a collection of individuals. The respondents in this study are domain experts across several organisations and we cannot consider them as a synergistic unit. So, AIP was chosen for data aggregation which was performed by calculating the geometric means.

3. Literature Review

There is an extensive body of prior research on blockchain but there is a relatively low number of papers on impeding and motivating factors for organizational blockchain adoption. The review yielded 10 relevant papers within Information Systems Research that were analyzed. The key motivating factors identified include: automation of transactions, reliability, decentralization, transparency and immutability. The key impeding factors include concerns about scalability, interoperability, cost and technical maturity. These are presented in the paragraphs that follow. A concept matrix providing an overview of the factors identified and the papers reviewed is presented in Table 1.

Transaction automation is identified as a driving force for blockchain introduction in organizations in the majority of the publications reviewed [5, 15-22]. "Enterprises of all types are increasingly interested in blockchain technologies because of the promise of significant business value. Blockchain solutions provide the ability to transact directly with trading partners, eliminate the need for reconciliations, track and trace assets instantly, ensure the provenance of data and settle transactions quickly and cheaply" [20]. The automation of transactions can have a big impact on efficiency, especially when there are interorganizational relationships and transactions across multiple different organizations.

Another key motivating factor identified in the literature relates to the benefits of having a reliable system that performs consistently [15-20, 22]. Blockchain technology has the potential to provide a reliable way of storing transaction data. A key characteristic of blockchain arrangements contributing to reliability is that there is no single point of failure. Hence, decentralization in terms of distributing authority and control is another key motivating factor for blockchain adoption[1, 5, 16, 17, 19, 22]. For instance, in a blockchain initiative reported by Beck & Müller-Boch [5], decentralization is mentioned as an important factor behind the initiative. Decentralization is expected to empower participants, moving trust from central parties to the network participants themselves.

In addition, transparency is identified in the literature as a motivating factor for organizational blockchain adoption [1, 5, 17-22]. Relying to central trusted third parties can result to low transparency of transactions and this is one of the key issues that blockchain is aiming to solve. Trusted third parties have ownership and control ledgers centrally, while providing little to no openness to other entities [20]. Blockchain can enable transparent actions, auditable by the

parties involved. Finally, immutability, has also been identified as a characteristic motivating organizations to introduce blockchain solutions [1, 5, 15, 18-20]. Blockchain enables organizations to keep an immutable ledger of transactions, which can be shared within a selected network, eliminating the need for involving trusted third parties. The ability of a blockchain ledger to remain unaltered ensures that no one can intrude changing the data saved. This characteristic can reshape the processes needed for data auditing and integrity assurance making them more efficient.

While prior research has pointed to a number of motivating factors for blockchain introduction in organizations, a number of concerns that slow down adoption have also been identified. Scalability concerns are a key impeding factor [15-22]. The current transaction speed and potential for growth in blockchain networks are low. The cryptography and consensus arrangements in place affect this. Cryptography enables only legitimate transactions to be processed but needs to be efficient enough for mainstream use. Consensus mechanisms determine how the shared ledger is updated, getting multiple network nodes to agree if a data entry is valid and should be added to the blockchain. Consensus mechanisms need to offer high throughput and low latency to enable-large scale applications.

Another concern, relates to interoperability [17, 19, 20, 22]. Blockchain solutions have low interoperability with existing systems, and there is currently no interoperability platform to enable communication between different blockchain implementations. Furthermore, the cost of implementing such a new technology, and the new operational costs entailed has been identified as a limiting factor [1, 15, 19, 21]. Organizations need to develop new competencies or hire new technology experts and add new technological components in their infrastructure. Finally, a significant concerns relates to the maturity of the technology [15, 17-19, 21]. There are technical issues that are still under investigation. For instance, currently blockchain arrangements can be very resource-intensive and energy consuming. Blockchain developers are experimenting with new arrangements that are less resource intensive but these are not mature yet.

Table 1. Key determinants of blockchain technology introduction in organizations identified in the literature reviewed

	Motivating Factors					Impeding Factors			
	Automation of transactions	Reliability	Decentralization	Transparency	Immutability	Scalability concerns	Interoperability concerns	Cost concerns	Maturity concerns
Beck et. al (2018), Governance in the Blockchain Economy: A Framework and Research Agenda, JAIS [15]	X	X			X	X		X	X
Beck et. al (2017), Blockchain technology in business and information systems research, BISE [1]			X	X	X			X	
Beck & Müller-Boch (2017), Blockchain as a radical innovation: A framework for engaging with distributed ledgers as incumbent organization, HICSS [5]	X		X	X	X				
Giraldo (2018), X-Border Platforms: the implications of distributed ledger technology, ECIS [16]	X	X	X			X			
Glaser (2017), Pervasive Decentralisation of Digital Infrastructures:, HICSS [17]	X	X	X	X		X	X		X
Gomber et. al (2018), On the Fintech Revolution: Interpreting the Forces of Innovation, Disruption, and Transformation in Financial Services, JMIS [18]	X	X		X	X	X			X
Hans et. al (2017), Blockchain and Smart Contracts: Disruptive Technologies for the Insurance Market, AMCIS [19]	X	X	X	X	X	X	X	X	X
Lacity (2018), Addressing key challenges to making enterprise blockchain applications a reality, MISQE [20]	X	X		X	X	X	X		
Risius & Spohrer (2017), A Blockchain Research Framework What We (don't) Know, Where We Go from Here, and How We Will Get There, BISE [21]	X			X		X		X	X
Schweizer et. al (2017), Unchaining Social Businesses – Blockchain as the Basic Technology of a Crowdlending Platform, ICIS [22]	X	X	X	X		X	X		X

4. Empirical Findings

The factors identified in the literature were used in the AHP pairwise comparisons. Specifically, the motivating factors included are: Automation of transactions, Reliability, Decentralization, Transparency, Immutability. The impeding factors identified in the literature and used in the AHP model are: Scalability concerns, Interoperability concerns, Cost concerns, Maturity concerns. Additionally, Knowledge concerns were also added as a fifth potentially impeding factor. The importance of knowledge developed and enacted in innovation processes of aligning heterogeneous business and technical elements has been identified in prior inter-organizational IT innovation research [23]. The use of AHP helped to get insights about the issues that matter the most for practitioners. Table 2 provides an overview of the relative weights for each factor based on the rankings of the professionals and also, a description of each factor which was also shared with professionals during the survey.

Table 2. Key determinants of blockchain technology introduction in organizations identified in the literature reviewed

Factors	Description	Professionals´ Weights
Motivating		
Automation of transactions	This factor relates to the benefits of automating transactions either within the organization or between organizations. This would in most scenarios be done using so-called "smart-contracts" (a computer program that directly controls the transfer of assets between parties under certain conditions).	12%
Reliability	This factor relates to the benefits of having a system that is consistently up and running and that always performs consistently under the same conditions. Minimal downtime and maximum predictability are key here.	**29%**
Decentralization	This factor relates to the benefits of decentralizing and ensuring distributed control among actors. For instance, in a supply chain, the different actors can share ownership and responsibility of updating and verifying records.	15%
Transparency	This factor relates to the benefits of enabling transparent actions, internally or between organizations that will be auditable by the parties involved.	22%
Immutability	This factor relates to the benefits of ensuring the ability to verify that data has not been altered. Immutability increases trust.	22%
Impeding		
Scalability Concerns	This factor relates to concerns about not being able to handle increasing volumes.	21%
Interoperability Concerns	This factor relates to the concern about lack of interoperability with existing internal or external systems.	19%
Cost Concerns	This factor relates to concerns about the cost of implementation and maintainance of blockchain solutions.	19%
Technical Maturity Concerns	This factor relates to concerns about lack of technical maturity of blockchain solutions.	**24%**
Knowledge Concerns	This barrier relates to concerns about insufficient knowledge about the technology, architectural arrangements, potential benefits and disadvantages.	16%

Interestingly, the most important motivating factor is *Reliability* while *Automation* of transactions (e.g. through smart contracts) and *Decentralization* scored significantly lower. Automation and decentralization are highlighted drivers in research literature and in the promotional arguments of consultants, but the interest for these is not well reflected in our data. Our findings show that smart contract automation and decentralization may not be as important to organizations as blockchain developers, researchers and promoters claim. The most important motivating factor is found to be the expectation for reliability. This is a very important aspect of infrastructural technologies. In general, the findings of this study show that key infrastructural qualities (reliability, transparency, immutability) are valued more than the transformative potential of blockchain technologies (automation of transactions, decentralization). The results for impeding factors indicate that *Technical Maturity Concerns* and *Scalability* concerns are slightly more prominent than the other factors.

5. Discussion and Conclusion

This study's findings provide insights about blockchain technology operationalization in practice, which is an under-researched topic in extant Information Systems research. Drawing on the literature and the empirical data analysis, our paper contributes insights for theory and practice. First, we show that the infrastructural nature of blockchain technology needs to be taken into account for understanding organizational adoption. The work of infrastructuring entails conceptualising new technological capabilities not as standalone objects, but as elements in larger arrangements, hence, concerns for embeddedness and durability are key [24]. This resonates with the findinhgs of this study that identify reliability, transparency and immutability as qualities that matter more than characteristics related to blockchain´s transformative potential (automation of transactions, decentralization). Furthermore, the results for impeding factors indicate that the most prominent concerns relate to maturity and scalability. These findings advance extant research by pointing to the importance of operationalizing blockchain as an operand resource before leveraging it as an operant resource capable of acting on other resources to create value [25]. Second, in contrast to most blockchain studies that investigate potentialities, our paper investigates the actual perspectives of practitioners that have experience with blockchain initiatives in their organizations. Most prior research on blockchain is focused on technical and high-level governance aspects and tends to ignore the practical issues that relate to blockchain introduction into organizations [8] and there is limited research oriented towards issues of blockchain adoption and applied business value creation [2]. This paper contributes towards filling this gap.

The paper has implications both for theory and practice. On the theoretical level, our study calls for a nuanced understanding of technology that influences the dynamics of innovation in information infrastructures. Specifically, we expose and conceptualize the role of technology dependability. As a contribution to practice we provide insights about operationalizing blockchain as an operand resource within organizations. More research is needed to investigate differences across industries. An example would be the importance of interoperability which matters for inter-organizational relationships in supply chains and business networks, while it is not as important for organisations that do not exchange much information across systems. Furthermore, it would be interesting to investigate differences between industries that are risk averse and cost sensitive and industries that embrace risk taking and invest resources into adopting new technologies. We argue that to advance our knowledge on the determinants of blockchain technology introduction in organizations, we need more empirical studies that show the issues faced and the concerns of organizations in different industries.

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