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BLOCKCHAIN – JUST ANOTHER IT IMPLEMENTATION? A COMPARISON OF BLOCKCHAIN AND INTERORGANIZATIONAL INFORMATION SYSTEMS

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Completed Research

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Abstract

In expectation of an impending technological disruption, organizations get familiar with blockchain technology and scout for first value delivering implementations. So far, the promises and expectations fall short and large scale blockchain applications and ecosystems, apart from cryptocurrencies, are still missing. One aspect that contributes to this shortcoming is that blockchain projects face a multitude of implementation barriers, which have not yet been systematically identified.

Blockchain can serve as a technological fabric, connecting different parties in a business network and facilitating information exchange. Such systems show clear resemblance to interorganizational information systems (IOIS). Therefore, the questions can be raised to what extent blockchain systems face the same implementation barriers as compared to any other IOIS implementation and, thus, if IOIS literature can be a valuable source for overcoming these barriers?

To investigate these questions, we conduct a series of interviews with experts that have implemented blockchain prototypes in an interorganizational context and compare the derived barriers with the results of a structured literature review on challenges of IOIS implementations. We identify technical, organizational and network challenges that emerge along the blockchain implementation process and illustrate how the development of blockchain-based systems extends the existing knowledge on IOIS.

Keywords: Blockchain technology, Technology adoption, Implementation challenges, Interorganizational information systems.

1 Introduction

Today, blockchain technology is on everyone's lips, marking a breakthrough, by promising to entirely change the way we digitally interact and transact (Tapscott and Tapscott, 2016). The technology has attracted a substantial hype, expecting it to create value in a wide variety of applications by enabling self-sufficient ecosystems (De Filippi, 2017; Michelman, 2017). In a business-to-business context, blockchain can potentially be used to facilitate transactions between actors of a network. Thus, enable efficient, trusted and secure collaboration without the need of labor- and capital-intensive efforts or a third party (Michelman, 2017). However, there is still a low level of adoption of blockchain solutions in industry networks (Lehdonvirta, 2016). Naturally, the diffusion of an emerging technology takes time and the introduction and piloting of a new information technology is often connected to a variety of challenges during its implementation process (Iansiti et al., 2017). Knowing and understanding these challenges can facilitate the implementation and eventually accelerate the adoption of blockchain technology (Beck et al., 2016; Zhao et al., 2016).

A glance into the past may contribute to identifying and overcoming these challenges. Similarly to EDI or other IOIS technologies, blockchain technology provides the means to perform transactions in a more efficient way, leading to lower transaction costs (Iansiti et al., 2017). Both blockchain and EDI enable the formation of interorganizational networks by serving as technological basis for connecting various parties throughout a business network – making a blockchain system an IOIS. EDI and other technologies have been thoroughly researched in context of IOIS (e.g. see Cunningham and Tynan, 1993; Iacovou et al., 1995). Drawing upon existing knowledge regarding the implementation of IOIS might, therefore, help to identify challenges of blockchain implementations and lay the foundations to leverage existing IOIS solution approaches and best practices in a blockchain context.

Therefore, we investigate *to what extend implementations of blockchain technology in business networks face the same barriers as IOIS implementations.* We seek to understand what challenges arise during the implementation and realization of blockchain technology in business networks and how they compare to challenges of IOIS implementations. This research contributes by broadening the application area of IOIS in order to leverage the existing body of knowledge on IOIS for blockchain implementations. It further contributes to the understanding of the implementation of blockchain technology in business networks. In our analysis, we appreciate that the diffusion and implementation of a complex and networked technology, such as blockchain or EDI, in a business network is the result of coordinated and collective action by multiple interdependent actors, who are embedded in socio-technical structures (Geels, 2004). Our work integrates the impact of material aspects of the technology, organizational factors as well as concepts, addressing its institutional embedding (Lyytinen and Damsgaard, 2001). To account for the complexity and multilayeredness of our research inquiry, we build upon studies that take the diffusion of innovation, organizational aspects of technology adoption (e.g. Chwelos et al., 2001) and institutional theory as their theoretical lenses (e.g. Teo et al., 2017).

To achieve our objective, we follow a two-step research approach. First, we conduct a series of semi-structured interviews, addressing the implementation of blockchain-based business networks with experts from industry that have substantial experience in the realization of blockchain projects. We apply qualitative content analysis in two cycles. (Krippendorff, 2013). In the initial, explorative cycle, we perform open coding to identify distinct challenges of blockchain projects. Preceding the second coding cycle, we conduct a structured literature review on the implementation challenges of IOIS and create a baseline of challenges that are known for this type of IT implementation. We extend the existing code structure with the challenges from literature and apply axial coding on the interview data, identifying similarities and differences between blockchain and IOIS implementations.

This paper is structured as follows: In section 2, we provide the necessary understanding of blockchain technology and briefly discuss its applicability in different types of information systems. Section 3 describes the applied methodology, regarding data acquisition and analysis. Section 4 gives an overview of the identified IOIS implementation barriers, which are used as the basis of our analysis. In section 5, we address these challenges with regard to blockchain implementations. The discussion in section 6 highlights the peculiarities of blockchain technology. We conclude our research by summing up our contributions, critically examining our limitations and highlighting potentials for future research.

2 Related Work

The following section gives a brief introduction on blockchain technology and provides a working definition for the subsequent analysis. Furthermore, the applicability of blockchain systems for internally or externally oriented information systems is discussed.

2.1 Blockchain Technology

Blockchain technology was first introduced as the underlying technology of Bitcoin (Nakamoto, 2008), in which it facilitates financial transactions in a peer-to-peer network with distributed consensus. Over the past years it has made its ways into other industries. Instead of relying on a trusted, centralized organization or institution, blockchain technology facilitates the decentralized aggregation and integration of resources (De Filippi, 2017). Trust in the delivery of a good or service is created through the technology itself rather than a company brand or reputation (Gawer and Cusumano, 2014). This is relevant to perform transactions between individuals in a system, but also in a B2B context, in which business interactions take place in a network of suppliers and purchasers. By now, the term blockchain subsumes a broad variety of different platforms, techniques and, in turn, definitions. Its application ranges from single organizations to multi-enterprise solutions as well as from distributed to centralized consensus. Yet, there is no common agreement whether all of these different manifestations can be called blockchain solutions (Wüst and Gervais, 2018).

For the purpose of this research, we build upon blockchain technology's original notion, applying the following general definition, specifying a blockchain as "[…] a distributed database, which is shared among and agreed upon a peer-to-peer network. It consists of a linked sequence of blocks, holding timestamped transactions that are secured by public-key cryptography and verified by the network community. Once an element is appended to the blockchain, it cannot be altered, turning a blockchain into an immutable record of past activity" (Seebacher and Schüritz, 2017, p. 14).

2.2 Blockchain-based Information Systems

Depending on the intended use of blockchain technology and the resulting perspective of the application, blockchain technology can either be regarded as internally or externally oriented information technology (cf. Table 1).

	Perspective	
	Internal	**External**
Application area	Provision and delivery of information in an organization, across organizational functions	Facilitation of information exchange across organizational boundaries
Type of information system	Enterprise information system (EIS)	Interorganizational information system (IOIS)
Example	Enterprise resource planning (ERP)	Electronic data interchange (EDI)

Table 1. Perspectives of information systems

In case of an internal orientation of a blockchain-based information system, similarities can be drawn to ERP implementations, as both ERP systems and blockchain solutions may represent transactional backbones, facilitating the digitization of a company (Ross et al., 2017). Cross-functional integration and information provision plays an important role for delivering ERP's functionality of e.g. tracking business resources or creating a unified enterprise view on transactions and data by granting swift access to current information (O'Brien and Marakas, 2010). Furthermore, ERP systems were originally introduced to knit fragmented legacy systems (Robey et al., 2002) as a mean for standardization and to facilitate automation of business processes (Yusuf et al., 2004). Similarly, blockchain is also expected to drive efficiency improvements within a single organization by providing a unified view on information, accelerating transaction speed (Lacity et al., 2018). Despite the mentioned similarities between ERP and blockchain systems, we would question the use of a blockchain system solely fulfilling an internal purpose of a single company. In a setting, where blockchain is applied in a single organization with a limited number of validators, contributing to reaching a consensus, we deem that its use is not justified, as its core functionality is solely used to a limited extent. In such cases, traditional IT solutions, relying on established centralized or decentralized databases seem more beneficial, e.g. in terms of efficiency.

Incorporating an external perspective and orientation, an IOIS facilitates the "creation, storage, transformation, and transmission of information" by interconnecting two or more parties via information technology, enabling the transmission of information across organizational boundaries (Johnston et al., 1988). Throughout the past decades, IOIS have become a well-established and well-researched subject in IS literature and there exists a broad variety of research papers analyzing the adoption and implementation of IOIS (e.g. (Barrett and Konsynski, 1982; Chwelos et al., 2001; Hekkala and Urquhart, 2013; Meier and Sprague, 1991; Rodón and Sesé, 2010)). Comparably to existing technologies that enable the formation of IOIS, blockchain technology can serve as technological fabric, interconnecting a set of companies, and thereby, facilitating information exchange across organizational boundaries. Its notion is based upon the premise of enabling interaction among untrusted parties. Yet, despite its concordance with other networked technologies, such as EDI, blockchain technology seems to be even more dependent upon collaboration and process integration. Where coordination and monitoring tasks have typically been performed by trusted third parties or authorities, with blockchain such centralized structures become replaced. The resulting decentralization requires its participants to be engage in collaboration (Seebacher and Schüritz, 2017). Therefore, the technology-based coupling of organizations demands renewed attention, in order to unveil present implementation approaches and challenges.

There are several publications that have already addressed challenges in the area of blockchain technology, e.g. barriers for business models (Halaburda and Sarvary, 2016; Swan, 2015), regulatory (Böhme et al., 2015; Wright and De Filippi, 2015) and technical challenges (McCorry et al., 2016; Vukolić, 2016; Weber et al., 2016). Moreover, Beck and Müller-Bloch (2017) developed a framework for engaging with blockchain technology in the banking industry. Fridgen et al. (2018) offer insights regarding use case derivation. Holotiuk and Moormann address the process of organizational adoption of blockchain technology (Holotiuk and Moormann, 2018). Still, blockchain technology's connection to IOIS as well as general implementation challenges remain unacknowledged. Learnings from the unequivocal overlap between IOIS and blockchain technology offers fruitful insights that support the implementation of blockchain solutions.

3 Methodology

In order to extend the body of knowledge on blockchain technology and barriers of its implementation process, we pursue an inductive research methodology following a two-step approach (cf. Fig.1). Through the combination of a series of expert interviews with a structured literature review, we intend to identify blockchain implementation challenges as well as assess similarities and differences with general IOIS implementation challenges.

3.1 Interview design and sampling

Knowledge about the implementation of blockchain in an interorganizational context is still limited. Therefore, we apply an inductive approach to overcome the lack of existing work (Eisenhardt and Graebner, 2007). We draw upon interviews with experts in this specific area and employ a generic purposive sampling based on a set of predefined selection criteria (Bryman, 2016): Interviewees have extensive business or technical knowledge, they are currently or have recently assumed a leading position in projects concerning the realization of a blockchain implementation, and either have a corporate background or work for consulting firms or technology providers. Involving the latter two, we benefit from their experience, having handled a large number of blockchain projects across a wide variety of industries and use cases. After a total of eleven interviews, the data collection process is concluded after no new insights were generated (cf. Table 2).

We use semi-structured interviews, which serve our research purpose, as they leave enough flexibility to identify and deal with unexpected aspects, while providing a minimal structure and increasing comparability (King, 2004). In this context, open questions regarding the process and challenges of blockchain implementation projects are posed. In order to gain additional insights and to clarify the statements of the interviewees, additional probing is performed (Bryman, 2016).

No.	Company	Industry	Role	Employees	Revenue
1	Alpha	Multinational technology consulting firm	Technical architect	>300,000	€70B–€150B
2			Business expert		
3	Beta	Multinational technology provider	Business consultant	120,000 – 150,000	€20B - €50B
4			Technical architect		
5	Gamma	Manufacturing, engineering technology, mobility	Product owner	>300,000	€70B- €150B
6	Delta	Manufacturing, engineering technology, mobility	Technical architect	250,000-300,000	>€150B
7			Technical architect		
8	Epsilon	Electric utilities	Technical & business expert	10,000-20,000	€10B - €20B
9	Zeta	Logistic, engineering technology, mobility	Technical architect	80,000-100,000	€20B - €50B
10	Eta	Logistic, engineering technology, mobility	Technical expert	120,000 – 150,000	€20B - €50B
11			Business expert		

Table 2. Overview of interviews

3.2 Literature review

We perform a systematic literature review to gain a sound understanding of IOIS and lay bare associated challenges regarding their implementation. We draw upon three scientific databases (EBSCOhost, SCOPUS, ScienceDirect) to ensure a comprehensive coverage of the subject. In an initial step, articles are identified by searching their titles and abstracts with a variety of keyword combinations (cf. Table 3). Since IOIS represent a well-researched topic, we rely on high ranked journal publications (VHB: A/ A+) to perform our analysis. The identified literature on IOIS is then analyzed using a concept matrix and, subsequently, is synthesized based on a workshop among fellow researchers.

Search term 1		Search term 2	EBSCO	Scopus	Science Direct	Relevant sum (w/o duplicates)
Interorganizational information systems	AND	Challenges OR Barriers OR Difficulties OR Issues OR Problems OR Limitations OR Obstacles	21	57	7	28
Inter-organizational information systems			16	117	11	
Interorganizational systems			37	107	11	
Inter-organizational systems			35	176	16	

Table 3. Literature review on barriers of interorganizational information systems

3.3 Coding process

Each interview lasted between 40 and 90 minutes, was recorded, after consent was granted, and in turn transcribed using the software MAXQDA. We apply qualitative content analysis to analyze the data (Krippendorff, 2013). In a first coding cycle, the interview transcripts are sequentially coded by two independent researchers, using open coding, to uncover relevant aspects regarding implementation challenges of blockchain applications. Open coding is employed to ensure openness towards new and potentially distinct aspects and nuances of blockchain technology (Charmaz, 2006). After each interview, consensus concerning the coding system is reached. In case of conflicting codes, a third researcher, who is also familiar with the topic, is used as a mediator to resolve discrepancies.

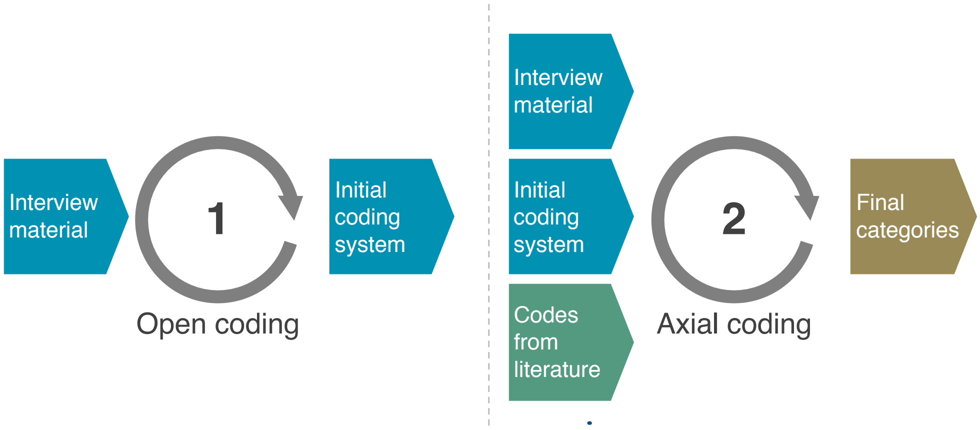

Figure 1. Qualitative data analysis process

Based on the systematic literature review, we uncover existing challenges of IOIS implementations. The identified aspects from literature serve as secondary coding base, which we use to extend the initial coding system. By applying axial coding on the interview data, we locate similarities and differences between blockchain and IOIS implementations. Axial coding serves as a means for re-grouping similar codes from different data sources and to eventually develop conceptual categories (Saldaña, 2009). Thereby, the derived IOIS implementation challenges from literature serve as theoretical anchor, refining the results and illustrating similarities and differences between blockchain and IOIS projects, and provide the theoretical foundation for developing sound conceptual categories of implementation challenges.

4 Implementation challenges of IOIS

Based on the structured literature review, we identify a set of almost two dozen challenges that we have grouped into three categories: technical barriers, organizational barriers and network barriers (see Table 4). The derived challenges build the basis for our analysis to investigate to what extent blockchain implementations face the same challenges as any other IOIS and are, thus, just another IT implementation.

Technical barriers	**Lack of technical capabilities** (Allen et al., 2000; Barrett and Konsynski, 1982; Chatterjee, 2013; Chwelos et al., 2001; Dong et al., 2017; Grover and Saeed, 2007; Hekkala and Urquhart, 2013; Holland et al., 1992; Howard et al., 2003; Iacovou et al., 1995; Legner and Schemm, 2008; Meier and Sprague, 1991; Messerschmidt and Hinz, 2013; Steinfield et al., 2011; Webster, 1995; Zhu et al., 2006)
	Compatibility of infrastructure/ IT (Bala and Venkatesh, 2007; Chatterjee, 2013; Christiaanse and Huigen, 1997; Dong et al., 2017; Grover and Saeed, 2007; Holland et al., 1992; Howard et al., 2003; Iacovou et al., 1995; Meier and Sprague, 1991; Premkumar et al., 1994; Robey et al., 2008; Steinfield et al., 2011; Webster, 1995)
	Missing IT standards (Allen et al., 2000; Christiaanse and Huigen, 1997; Chwelos et al., 2001; Dong et al., 2017; Howard et al., 2003; Hsu et al., 2015; Johnston and Gregor, 2000; Meier, 1995; Premkumar et al., 1994; Steinfield et al., 2011; Webster, 1995)

Table 4. Barriers of interorganizational information system implementations

Organizational barriers	**Project management issues** (Allen et al., 2000; Christiaanse and Huigen, 1997; Dong et al., 2017; Grover and Saeed, 2007; Hekkala and Urquhart, 2013; Holland et al., 1992; Howard et al., 2003; Legner and Schemm, 2008; Steinfield et al., 2011; Zhu et al., 2006)
	Organizational readiness (Bala and Venkatesh, 2007; Chatterjee, 2013; Chwelos et al., 2001; Cunningham and Tynan, 1993; Grover and Saeed, 2007; Howard et al., 2003; Iacovou et al., 1995; Legner and Schemm, 2008; Meier and Sprague, 1991; Messerschmidt and Hinz, 2013; Riggins et al., 1994; Robey et al., 2008; Rodón and Sesé, 2010; Steinfield et al., 2011; Webster, 1995; Zhu et al., 2006)
	Top management support (Bala and Venkatesh, 2007; Barrett and Konsynski, 1982; Grover and Saeed, 2007; Howard et al., 2003; Hsu et al., 2015; Iacovou et al., 1995; Messerschmidt and Hinz, 2013; Robey et al., 2008; Rodón and Sesé, 2010; Zhu et al., 2006)
	Participation cost (Bala and Venkatesh, 2007; Barrett and Konsynski, 1982; Chatterjee, 2013; Christiaanse and Huigen, 1997; Chwelos et al., 2001; Grover and Saeed, 2007; Iacovou et al., 1995; Johnston and Gregor, 2000; Legner and Schemm, 2008; Messerschmidt and Hinz, 2013; Robey et al., 2008; Steinfield et al., 2011; Webster, 1995; Zhu et al., 2006)
	Lock-in effect & maintenance of parallel IT (Howard et al., 2003; Iacovou et al., 1995; Johnston and Gregor, 2000; Meier, 1995; Riggins et al., 1994; Steinfield et al., 2011; Webster, 1995; Zhu et al., 2006)
	Legal implications (Cunningham and Tynan, 1993; Dong et al., 2017; Hsu et al., 2015; Meier and Sprague, 1991; Zhu et al., 2006)
	Internal resistance (Allen et al., 2000; Howard et al., 2003; Messerschmidt and Hinz, 2013; Premkumar et al., 1994; Rodón and Sesé, 2010; Steinfield et al., 2011; Zhu et al., 2006)
	Technology-driven implementation (Chatterjee, 2013; Dong et al., 2017; Legner and Schemm, 2008; Meier, 1995; Messerschmidt and Hinz, 2013; Steinfield et al., 2011)
	Awareness & perception of benefits (Allen et al., 2000; Christiaanse and Huigen, 1997; Chwelos et al., 2001; Grover and Saeed, 2007; Holland et al., 1992; Howard et al., 2003; Hsu et al., 2015; Iacovou et al., 1995; Johnston and Gregor, 2000; Legner and Schemm, 2008; Meier and Sprague, 1991; Messerschmidt and Hinz, 2013; Premkumar et al., 1994; Riggins et al., 1994; Robey et al., 2008; Steinfield et al., 2011; Webster, 1995; Zhu et al., 2006)
Network barriers	**Control over information resource** (Allen et al., 2000; Bala and Venkatesh, 2007; Chatterjee, 2013; Christiaanse and Huigen, 1997; Chwelos et al., 2001; Cunningham and Tynan, 1993; Holland et al., 1992; Howard et al., 2003; Messerschmidt and Hinz, 2013; Zhu et al., 2006)
	Compatibility of business & social structures (Allen et al., 2000; Bala and Venkatesh, 2007; Chatterjee, 2013; Christiaanse and Huigen, 1997; Dong et al., 2017; Holland et al., 1992; Howard et al., 2003; Legner and Schemm, 2008; Meier, 1995; Meier and Sprague, 1991; Messerschmidt and Hinz, 2013; Premkumar et al., 1994; Robey et al., 2008; Rodón and Sesé, 2010; Steinfield et al., 2011; Webster, 1995; Zhu et al., 2006)
	Harnessing of network externalities (Bala and Venkatesh, 2007; Chwelos et al., 2001; Howard et al., 2003; Iacovou et al., 1995; Legner and Schemm, 2008; Meier, 1995; Messerschmidt and Hinz, 2013; Riggins et al., 1994; Robey et al., 2008; Steinfield et al., 2011; Zhu et al., 2006)
	Collaborative mindset (Holland et al., 1992; Howard et al., 2003; Hsu et al., 2015; Johnston and Gregor, 2000; Messerschmidt and Hinz, 2013)
	Adoption behavior of competitors (Chwelos et al., 2001; Grover and Saeed, 2007; Holland et al., 1992; Meier, 1995; Messerschmidt and Hinz, 2013; Robey et al., 2008; Rodón and Sesé, 2010)
	Cultural bias (Bala and Venkatesh, 2007; Christiaanse and Huigen, 1997; Dong et al., 2017; Hekkala and Urquhart, 2013; Howard et al., 2003; Hsu et al., 2015; Meier and Sprague, 1991; Messerschmidt and Hinz, 2013; Robey et al., 2008; Rodón and Sesé, 2010)
	Trust (Allen et al., 2000; Bala and Venkatesh, 2007; Chwelos et al., 2001; Grover and Saeed, 2007; Howard et al., 2003; Hsu et al., 2015; Iacovou et al., 1995; Meier, 1995; Messerschmidt and Hinz, 2013; Robey et al., 2008)
	Degree of dependency & power structures (Allen et al., 2000; Bala and Venkatesh, 2007; Barrett and Konsynski, 1982; Chatterjee, 2013; Christiaanse and Huigen, 1997; Chwelos et al., 2001; Cunningham and Tynan, 1993; Dong et al., 2017; Grover and Saeed, 2007; Howard et al., 2003; Hsu et al., 2015; Iacovou et al., 1995; Johnston and Gregor, 2000; Legner and Schemm, 2008; Meier, 1995; Messerschmidt and Hinz, 2013; Riggins et al., 1994; Robey et al., 2008; Rodón and Sesé, 2010; Steinfield et al., 2011; Webster, 1995; Zhu et al., 2006)
	Missing goal alignment (Allen et al., 2000; Cunningham and Tynan, 1993; Hekkala and Urquhart, 2013; Hsu et al., 2015; Messerschmidt and Hinz, 2013; Webster, 1995)

Table 5 (continued). Barriers of interorganizational information system implementations

5 Barriers of blockchain projects

During the implementation of blockchain systems, several challenges can be observed. We assess blockchain as means to connect and integrate various parties and organizations via information technology and, therefore, regard such systems as IOIS. In this section, we match the identified challenges, resulting from the conducted expert interviews, to the derived barriers from literature and organize them with regard to technical, organizational as well as network challenges.

5.1 Technical challenges

Projects, dealing with the introduction of a new technology, typically encounter a set of technical challenges (see Fig.Figure 2). In blockchain systems, these barriers are amplified by the technology's immaturity.

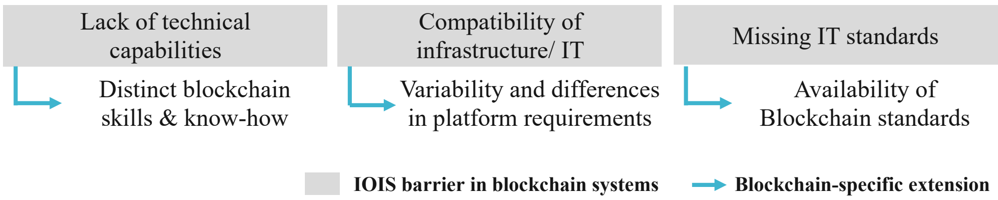

Figure 2. Technical barriers of IOIS and blockchain implementations

In order to effectively and efficiently introduce a technology, **technical capabilities** are necessary to overcome initial barriers induced by the technology (Steinfield et al., 2011). Yet, ensuring the availability of such capabilities becomes a major hurdle in the implementation process (Meier and Sprague, 1991). This holds especially true for current blockchain endeavors, for which "organizations are just starting to build up and develop distinct blockchain capabilities, e.g. with regard to decentralized infrastructure and privacy" (Interview 7). The immaturity of the technology, lacking documentation as well as the sheer amount of different blockchain platforms increase the severity of this challenge.

Another manifestation of technical barriers arises due to **compatibility** issues between the aspired and existing IT infrastructure. This is especially challenging in an interorganizational context, where compatibility of hard- and software between trading partners is of vital importance (Holland et al., 1992; Premkumar et al., 1994). The integration and adjustment process becomes a complex undertaking (Robey et al., 2008), e.g. requiring the adaptation of the existing legacy system (Iacovou et al., 1995). In case of blockchain technology, we can also observe this challenge, which, again, is connected to uncertainties due to the technology's immaturity and the variety of blockchain platforms.

Missing IT standards mark another challenge in the implementation of IOIS (Steinfield et al., 2011). Industry and data standards are a necessary means for ensuring data transfer across organizations (Hsu et al., 2015). In case of blockchain technology, there is no single dominant platform, but an uncontrolled proliferation of platforms and technologies. Therefore, efforts must be made to ensure that "the underlying code is open source and open standards are introduced" (Interview 7).

5.2 Organizational challenges

A variety of IOIS implementation challenges can be attributed to an organizational level (see Fig. Figure 3).

Due to the complexity of IOIS implementations, **project management** related tasks such as the coordination of project teams, installation of clear goals and stakeholder management remain a challenge in the development of an IOIS (Hekkala and Urquhart, 2013). Since, the implementation of blockchain technology is dependent upon a critical mass, dealing with an increased number of partners is challenging. Thereby, the integration and attunement of individual stakeholder interests may require additional efforts with regard to project management.

IOIS projects face uncertainties regarding **participation costs**. The adoption of a new technology requires the availability of financial resources, laying bare a key challenge (Zhu et al., 2006). "Such systems become very complex, very quickly. In each project, you have to be careful to stay within time and investment constraints" (Interview 2). The implementation of a blockchain project is connected to "a lot of vagueness or blurriness" (Interview 5), making it difficult to predict participation costs.

IOIS require **organizational readiness** to guarantee the "[...] availability of the needed organizational resources for adoption [...]" (Iacovou et al., 1995, p. 467). Currently, companies usually lack the necessary resources to perform blockchain implementations. Therefore, they tend to fall back to technology providers or consulting firms to offer support during the realization of such projects. Since, there is not a single dominant blockchain platform, companies are yet required to stay platform agnostic, while spending more resources on multiple implementations of the same use case, forcing them to pursue a "wait and see strategy" (Interview 5).

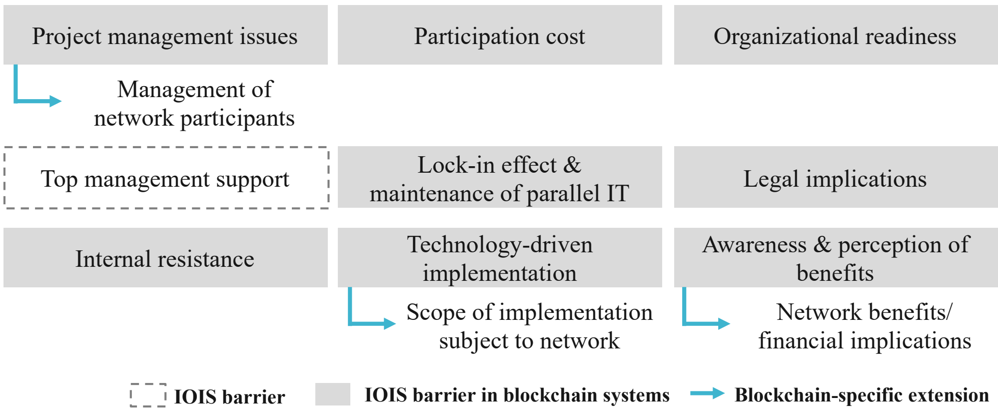

Figure 3. Organizational barriers of IOIS and blockchain implementations

Large scale implementations of IOIS usually require **top management commitment and support** to overcome organizational hurdles (Iacovou et al., 1995). Currently, this does not seem to be an issue for blockchain projects as "in contrast to other technologies, blockchain seems to be very much driven by CEOs, CIOs and CFOs […]. The awareness is much higher on an executive level" (Interview 5).

When confronted with the introduction of a new technology, companies are concerned to experience yet another **lock-in effect** (Webster, 1995). Especially for networked technologies, companies often have to follow the resource- and cost-intensive way of maintaining a **parallel infrastructure** with different groups of partners (Iacovou et al., 1995). The same holds true for blockchain systems, which might generate yet another IT system for a specific group of partners.

IOIS are further challenged by **legal barriers**, because partner organizations may be located in different jurisdictions and, therefore, subject to differing regulatory requirements (Hsu et al., 2015). Blockchain technology is designed to replace long existing intermediaries that have been obliged to follow regulation. Removing the need for these intermediaries tears a hole, without binding jurisdiction. Organizations face several questions such as "'What regulatory requirements do we have? What am I allowed to do with it?'" (Interview 5). Yet, where regulation exists, there may be country-specific differences, e.g. restrictions of encryption algorithms in certain countries.

Resistance to change is another barrier that organizations have to face when pursing an IOIS implementation (Howard et al., 2003). Blockchain projects also face resistance "ranging from 'Why do I even have to get engaged?', 'This is never going to work. Stop dreaming, guys!' to 'I have never seen something like this, I prefer to rely on my existing infrastructure'" (Interview 5).

Purely **technology-driven implementations** threaten the success of an IOIS project. IOIS implementations should focus on solving business needs, instead of solely following a technology-driven agenda (Meier, 1995). Especially in case of blockchain, for which its purpose is not predetermined, "it is important to have an eye on whether blockchain is really solving problems. From the perspective of technology vendors, they might be interested in just selling their product instead of a solution" (Interview 9). Furthermore, benefits and business needs are very much dependent upon the composition of the blockchain business network, as varying constellations of stakeholders offer distinct opportunities to address differing business needs. Yet, organizations tend to deal with too narrow use cases, missing their chance to reap network benefits and to address larger business issues.

A missing **awareness and lacking perception of the benefits** that are connected to the introduction of a technology hinder the development of an IOIS. The individual motivation of organizations to join an

IOIS is, amongst others, depends upon a proper awareness and perception of expected benefits. Yet, awareness and perception may, for instance, depend upon compatibility, IT sophistication (Chwelos et al., 2001). With blockchain, "it is hard to determine and quantify its benefits. I am certain that there will be second order effects, which we do not yet know about" (Interview 7). Furthermore, financial implications and benefits are also dependent upon the respective network composition, and are, therefore, subject to the stability of the network.

5.3 Network challenges

The implementation of an IOIS is dependent upon a network of organizations. Therefore, taking a network perspective, lays bare additional challenges (see Fig. Figure 4).

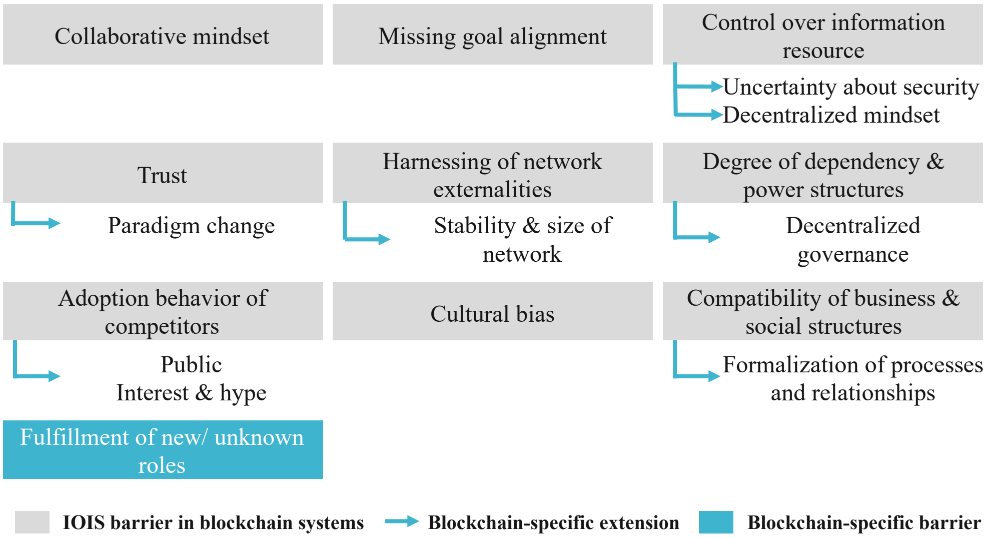

Figure 4. Network barriers of IOIS and blockchain implementations

Although, the importance of a **collaborative mindset** has long been stated in context of IOIS (Howard et al., 2003), it is still a very "difficult challenge [to set up] a community and encouraging [such] a […] mindset" (Interview 7). IOIS as well as "blockchain projects are destined to fail when only one company is willing to put effort in the introduction of such a solution - It takes a community!" (Interview 7). Without central authorities, blockchain technology seems to even require an advanced collaborative mindset, thoroughly building upon and enabling collaboration (Seebacher and Schüritz, 2017).

A missing **goal alignment** between network participants reveals a crucial challenge. "The network consists [...] of many actors with both differing and common goals in a 'struggle' to determine the nature of the network" (Cunningham and Tynan, 1993, p. 22). A blockchain business network intends to connect "a heterogeneous set of organizations, dealing with a common business case, handling a common asset" (Interview 2). Yet, a common understanding of rules and goals remains a challenge. It still can be observed that "[...] some participants focus on personal or company incentive, instead of sharing and thinking about a global incentive for all peers" (Interview 9).

Setting up technological ties between companies is often connected to a fear of **loss over power and control**, potentially resulting inertia (Bala and Venkatesh, 2007). Regardless of the potential benefits, organizations are often too afraid to give up control over their information resources (Howard et al., 2003). Blockchain thoroughly builds upon a decentralized mindset and engagement in a network. Yet, "companies still have a difficult relationship with decentralization. The stakeholders […] are often looking for centralization, because they are insecure about compliance and want to have security standards in place" (Interview 9). Furthermore, data privacy, security and control are still open topics that have to be assessed in context of blockchain technology (Risius and Spohrer, 2017). The technology aims to reduce or eliminate the need for an intermediary or authority, but "if [they] become obsolete, who is responsible in the end […] when things go wrong?" (Interview 3).

Missing **trust** is a vital issue, restraining the development of a collaborative environment (Meier, 1995). With regard to IOIS, the call for trust is twofold. A trust-based relationship between participants is necessary to foster interaction. The participants have to trust the underlying technology, regarding "robustness, reliability, and security" (Messerschmidt and Hinz, 2013, p. 142). In case of blockchain technology, the necessity of trust in the technology is even more prevalent. It requires a paradigm change, shifting the perspective from trusting institutions and organizations to mostly trusting technology. "Do I trust some developers more than institutions that grew big for decades?" (Interview 3).

A missing ability to **harness network externalities** challenges the success of an IOIS project (Steinfield et al., 2011). A critical mass is necessary to leverage the merits of an IOIS, as its utility tends to grow with the number of participants (Meier, 1995). Although, it may be easy to identify relevant partners for a blockchain project, convincing them to join and stay is challenging. Network size and stability are, therefore, two major issues in blockchain projects. "The probability that two, three or four potential partners quit is quite high" (Interview 1).

Existing relationships and power structures, establishing institutional pressures, may negatively influence the implementation of an IOIS (Teo et al., 2017). In case of coercive pressures, dominant stakeholders may use an existing imbalance of power to force their trading partners to join an IOIS, oblige to certain governance and design decisions, thereby, securing their power (Webster, 1995). Yet, decentralized governance is still an open issue in context of blockchain technology (Beck et al., 2018), as "in a decentralized setting, governance should not be developed by just one or two parties" (Interview 7).

The misperception of **mimetic and competitive pressure** lays bare another network challenge. These institutional pressures, involve the adoption behavior of competitors or "structurally equivalent organizations" (Teo et al., 2017, p. 21). Misperception may lead to the adoption of an IOIS that, in fact, may not be suited for a distinct company or industry. Due to the hype on blockchain technology, organizations may be inclined to pick an arbitrary use case just to be part of the blockchain movement – "at the peak of the hype cycle, […] some want blockchain just for the buzzword" (Interview 3).

Cultural bias constitutes another implementation barrier of an IOIS. Such biases may arise, due to differing normative origins of the individual organizations. The culture of an organization may lead to routine rigidities, hindering collaboration (Bala and Venkatesh, 2007). Such institutional distance negatively impacts the development of mutual beliefs, goals or practices (Dong et al., 2017).

Missing **compatibility regarding business and social structures** (Messerschmidt and Hinz, 2013), may lead to structural contradictions, which can be perceived as harmful (Rodón and Sesé, 2010). Yet, blockchain transforms business and social structures, as it requires an advanced formalization of processes and relationships, enabling automation. The underlying "if-then conditions […] have to be covered by agreements beforehand" (Interview 2). Nevertheless, the potential for formalization is limited by a lack of a common language or process logic. Reaching a common process understanding is, especially, challenging across organizations. "Overseeing an entire process is hard [...] we keep discussing how the business processes actually work" (Interview 1).

An entirely new barrier in blockchain systems is, that participant, especially the initiators of a blockchain network, might have to take on a **new role** as network orchestrators. „As an initiator, you are responsible for managing network externalities by developing and maintaining a sufficient network" (Interview 7).

6 Discussion

One could argue that blockchain-based business networks are just another IOIS implementation and, therefore, share the same, already known, challenges. For instance, blockchain implementations are subject to technological barriers, typical for emerging technologies in information systems, such as missing IT standards and insufficient available knowledge and capabilities. The development of a blockchain system also faces internal resistance, opposing alterations of established technologies and processes, which is common to the introduction of a new or the replacement of an existing information technology. On a network-level, the choice of conducting a blockchain implementations is subject to mimetic and competitive pressures, which when misinterpreted, result in a poor fit between technology and business problem at hand – again, also common to IOIS implementations. This argues for treating blockchain implementations like any other IOIS implementation and leveraging the existing body of knowledge.

However, our analysis also revealed that blockchain implementations extend the existing understanding of development barriers of IOIS. First, for blockchain systems, coping with decentralization becomes an even more pivotal part as compared to previous IOIS systems. This can, especially, be observed in the distribution and allocation of authority. Past IOIS implementations have typically been subject to coercive pressures, which dominant stakeholders imposed on their trading partners. This created hierarchically organized governance and design decisions (Webster, 1995). While coercive pressures can still be observed in blockchain projects, the technology provides the basis to build decentrally governed information systems. In such, network participants are reliably involved in the decision making and governance process. Yet, concepts for decentralized governance in blockchain systems are still under development (Beck et al., 2018).

Second, although, the usefulness of an IOIS is dependent on the level of collaboration between the involved companies (Holland et al., 1992), reluctance towards information sharing can be observed (Howard et al., 2003). The engagement in an IOIS is often accompanied by a fear of loss over power or reduced control over information resources (Webster, 1995). Blockchain systems are designed to share information throughout a decentralized network, in absence of a trusted third party. Therefore, fear of loss of power and control are even amplified and need to be coped with.

Third, a broadening of the perspective from a business-need driven to a network-need driven implementation is a central issue of a blockchain system. In the past, a major challenge for the adoption of an information system was to match technological specifications with business needs (Davenport, 1998). From the perspective of a single organization, the introduction of a certain technology yielded a benefit when solving a distinct business problem within that organization. In the past, companies had to make sure to follow a business-need driven instead of a solely technology-driven agenda (Meier, 1995), but still failed to take a broader perspective "thinking for all partners" (Howard et al., 2003, p. 29) in a collaborative manner. In blockchain systems, companies have to embrace network-needs, as the benefit for a single network participant depends upon the result and success of the entire network. In order for the network to function and to maintain stable, organizations have to be aware of the needs of their partners, as well as of effects of their decisions on the respective network. As there are currently few off-the-shelf blockchain solutions, such network-need considerations start with the composition of the network participants and the development of the respective use case, since the purpose of the network varies and adapts with the integration of new network members. This is in line with Norman, stating that "innovation is a systems issue" (Norman, 2010, p. 40).

Fourth, blockchain technology requires an adapted perspective on the concept of trust in a technology. In past IOIS endeavors, the notion of trust included both trust in a technology as well as trust in other participants, e.g. such as network partners or intermediaries (Messerschmidt and Hinz, 2013). In blockchain systems, trust in a technology is underscored, since the technology is inherently designed to reduce or eliminate intermediaries. Tasks, for which, traditionally, intermediaries are responsible and accountable, can now be performed by the technology itself. Therefore, network participants have to get used to fully rely on a technology, instead of having a third party, whom they can hold responsible.

Fifth, the business and social structures of the network participants not only have to be compatible with an information system, but also have to be formalizable. Studies on IOIS identified that contradictions of existing structures (Rodón and Sesé, 2010) as well as structural changes related to the introduction of an IOIS may negatively impact the adoption of such a system (Bala and Venkatesh, 2007). Yet, blockchain builds upon the transformation of business and social structures, as it requires a high degree of formalization or digitalization with regard to processes and relationships to fully reap the benefits of automation. Amongst others, formalization is needed to enable inherent coordination mechanisms, e.g. on the basis of smart contracts, which trigger the automated execution of processes. While there are certainly processes and relational aspects that can easily be formalized, the opposite is also true and, therefore, has to be dealt with when implementing blockchain solutions.

Sixth, compared to existing IOIS implementations, a new barrier arises for organizations that take on an initiating role in developing a blockchain system. Especially during the implementation phase, such organizations have to take on a potentially unfamiliar role and position in a business network, e.g. becoming a platform orchestrator, thereby, being responsible to secure network size and stability.

Based on these findings, we can conclude that learnings from existing IOIS projects can be applied to blockchain implementations in business networks. Furthermore, insights from blockchain systems extend the understanding of IOIS, as organizations in blockchain implementations have to deal with the requirements of decentralization, overcome silo mentality, build upon technology as trusted party, do the splits between necessity for formalization and formalizability, as well as take on potentially new roles in a business network. Based on this analysis, we uncover white spots, which should be addressed to advance the field of blockchain research. Furthermore, by identifying similarities between IOIS and blockchain systems as well as novel aspects of blockchain implementations, we provide managers with a comprehensive overview of aspects, relevant for conducting blockchain projects.

7 Conclusion

Our analysis compares challenges of blockchain and general IOIS implementations. We draw upon a structured literature review as well as a series of expert interviews to make the following contributions.

First, based on the structured literature review, we generate a comprehensive overview over existing barriers in IOIS implementations, which we group into technical, organizational and network challenges. Second, we broaden and advance the understanding on blockchain projects by identifying and describing the occurring challenges, hindering the implementation of blockchain technology. Third, through a comparative analysis, we show that the development of a blockchain systems induces several barriers that extend the current view on IOIS challenges, e.g. with regard to the development of a decentralized mindset, the consideration and variability of network needs, the design of the business network, the notion of trust in a technology, the advanced formalization of relationships and processes as well as the emergence of new network roles. By identifying implementation barriers that are specific to blockchain systems, we also contribute to expanding the understanding of IOIS. We want to stress that quite an amount of current blockchain implementation challenges, such as the lack of know-how and uncertainties regarding data security, can be attributed to the technology's immaturity and the vast amount of existing blockchain platforms. Yet, these technological challenges are eventually expected to disappear.

Based on our findings, the following managerial implications can be observed. Managers, involved in developing a blockchain system, can benefit from this study as it provides an overview over common pitfalls during the development of IOIS and illustrates distinct barriers of blockchain implementations. Furthermore, the importance of business network aspects in the implementation process is highlighted in this study. In order for blockchain projects to succeed, practitioners have to actively engage in co-designing the business network and have to be aware of the resulting network-needs.

8 Limitations & Future research

With regard to the conducted interviews, our study is exposed to limitations. First, there is currently only a limited amount of companies implementing blockchain solutions and willing to talk about their experiences. We compensate this issue by including consultancies as well as technology providers, who in turn have been involved in a multiplicity of different blockchain projects. Yet, dealing with aggregated experiences of consultancies and technology providers may induce the second limitation of potentially leaving the activity of abstraction and interpretation to the interviewees. We attempt to avoid this issue by thoroughly relying on probing to uncover raw concepts and categories for our analysis.

As part of our work, we are able to illustrate that blockchain systems extend the existing understanding of IOIS. Therefore, future research can address several aspects of this study. For instance, to provide thorough guidance in the development of blockchain systems, a study identifying key success factors as well as relevant capabilities should be performed. An initial step might be the derivation such factors and capabilities from IOIS literature and a further extension of the analysis through in-depth case studies. As illustrated in this study, business network aspects play an important role in the development of blockchain systems. Therefore, the impact of network characteristics should be further investigated. Furthermore, decentralization is a key part of blockchain systems, e.g. with regard to decentralized governance, and should, therefore, be a subject of investigation. In this context, an overview over different on- and off-chain governance mechanisms as well as an analysis regarding their applicability could contribute to the development of blockchain solutions.

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