A Framework for Analysing Blockchain Technology Adoption: Integrating Institutional, Market and Technical Factors

Abstract

The adoption of blockchain technologies requires the consideration of a broad range of factors, over and above the predominantly technology focus of most current work. The aim of this research is to propose a framework capturing the challenges and issues that organisations face when adopting blockchain technology. Based on the systematic literature review the following factors affecting blockchain adoption were identified: institutional factors (norms and culture, regulations and legislations, governance), market factors (market structure, contracts and agreements, business process) and technical factors (information exchange and transactions, distributed ledgers, shared infrastructure). The resulting comprehensive model for adoption of blockchain technology shows the complex relationships at play between the factors. This is the first comprehensive framework that integrates the main factors around the adoption of blockchain technology. The framework highlights that varying outcomes are possible, and the change process is focal as this shapes the form blockchain applications take. Factors presented in this framework (institutional, market and technical) interact and mutually influence each other. The proposed framework can be used by organisations as a reference point for adopting blockchain applications and by scholars to expand, refine and evaluate research into blockchain technology.

Keywords Blockchain technology, Distributed ledger, Adoption, Diffusion, Trust, Markets, Intermediaries

1. Introduction

The recent emergence of blockchain technology has been heralded as the next revolution that will transform the shape and size of organisations and the way business transactions are conducted (Cermeño, 2016). However, like with all new innovations, early adopters have encountered many challenges prompting technical experts and researchers to debate the merits of blockchain technology during its present - early evolutionary phase. A blockchain can be explained as a series of blocks that records data in hash functions with timestamp and a link to the previous block (Crosby et al., 2016). The data is stored at different nodes in a so-called distributed ledger. This eliminates centralized points of vulnerability, which cybercriminals can exploit. Blockchain arrangements enable the storage of information that is not easy to mutate, be used to introduce tokens that can be transferred from one party to another party without the need for having a trusted third party or intermediary or for the automatic execution of “smart contracts” when specific conditions are met (Marsal-Llacuna, 2018).

While the use of blockchains is growing across industry sectors from logistics operations to manufacturing and public services, it has been growing most rapidly in financial services. The most common association is Cryptocurrency. Crypto tokens (short for “cryptographic tokens”) are defined as special types of virtual currency tokens that reside on their own blockchains, representing an asset or utility (Buterin, 2013; Wood, 2014). Tokens can be used for 1) cryptocurrencies, 2) utility tokens and 3) tokenized securities/investment tokens (Benoliel, 2017). In this and other forms of blockchain adoption, the concept of distributed ledger forms the basis for how information is gathered and communicated between users. Distributed ledgers allow users to move beyond the simple custodianship of a database and divert energy to how a database is used, manipulated and value extracted from it – in other words it is about managing a system of records rather than maintaining a database (Bauerle, 2018). In this respect, ‘smart contracts’ become significant between users. A smart contract defines the rules and penalties around an agreement and automatically executes and enforces the obligation in the contract. It can be defined as “a mechanism involving digital assets and two or more parties, where some or all of the parties put assets in and assets are automatically redistributed among those parties according to a formula based on certain data that is not known at the time the contract is initiated” (Buterin, 2014, para. 2).

Blockchain based architectures are currently being developed for a number of applications. For example, Engelenburg *et al.* (2017) developed a blockchain-based architecture for secure and reliable information exchange between organisations. Block.one's EOS.io, launched in January 2019, presents itself as a decentralized application hosting, with the ability to operate smart contracts and decentralized storage enterprise solutions (essentially a distributed Operating System) aiming at overcoming scalability of existing blockchains such as Ethereum, enabling millions of transactions per second (Lee *et al.,* 2018; Shah, 2019). American Express has just deployed Hyperledger's (Androulaki *et al.,* 2018; Cachin, 2016) Blockchain technology to improve the versatility of their rewards programme for greatly improved product-target offers (Sweet, 2018), whereas IBM has launched Blockchain as a Service (BaaS) on the Hyperledger Fabric open source blockchain architecture, to enable the setup of scalable, high throughput (Vukolić, 2015) trusted networks across private, public and government actors (Miller, 2017).

The introduction of disruptive technologies to any sector brings with it multiple challenges and complexities across technical, regulatory, social, and adoption-related areas. Yet, most of the work in blockchain has a technology focus and takes a simplistic view on organisations and institutional issues (Ølnes *et al.,* 2017). Often it is argued that reliance on intermediaries become obsolete in different business transactions when utilizing blockchain technology - as trust will be created by the concept of blockchain technology itself (Palfreyman, 2015). However, there is still a need for governance to design, operate and maintain the system within constellations of organizations (Ølnes *et al.*, 2017). Trust is related to both the technology as well as to those players who are governing the technology.

While literature on blockchain technology is only beginning to emerge, it is clear from early research that a broader view is needed for organizational adoption. As with most new innovations and disruptive technologies, when exploiting their potential, it is important to comprehend the potential challenges and complexities associated with them to mitigate risks and avoid the technical, social and political consequences of failure. *The objective of this paper is to develop a framework for capturing the challenges and issues organisations will face when adopting blockchain technology.*

This paper is structured as follows. In the following section we describe the research approach being used. After this, section three outlines factors affecting adoption of blockchain divided in three groups: institutional aspects, market aspects, and technical aspects. Next, the conceptual framework for analysing blockchain is presented. The paper is then concluded with the overview of the proposed framework, following by limitations and directions for future research.

2. Research approach

In order to develop the conceptual framework, the authors first reviewed the extant technology and organisations related literature to identify the main factors around blockchain technology. This review revealed a number of diverse factors that needed to be considered by organisations and raised the questions of how the adoption of this disruptive technology can be best managed. Hence, this research categorized these factors based on the institutional framework of Koppenjan and Groenewegen (2005) into institutional, market and technical factors. This framework is useful given the technology component, many parties involved, and market forces playing a role (ibid). The technology component in blockchain is quite disruptive as it can be shaped in different ways by the influence of the actors and markets. As such, Koppenjan and Groenewegen work offers a suitable reference point to map the relevant technical as well as institutional and market factors

An initial simple search for the keywords ‘blockchain’ and ‘adoption’ resulted in more than 800 results in databases such as Web of Science, Business Source Complete, Scopus and Google Scholar. By reading the abstract of each 800 papers it was found that only few of them (31 papers) focused on blockchain adoption as an objective. These 31 papers were all read and relevant factors were identified. The aim was to identify factors that were relevant and in line with the objective of this research. This resulted in 26 factors, which we categorised using Koppenjan and Groenewegen’s framework as described in the next section.

3. Factors affecting adoption of blockchain technology

Based on the literature found in relation to the adoption of blockchain technologies, a large number of heterogeneous factors were found. Using Koppenjan and Groenwegen's framework the factors were divided into three dimensions: institutional, market and technical. The following subsections provides a detailed description of these factors.

3.1 Institutional factors

Institutional arrangements can be viewed as a set of rules that regulate the interaction between parties (Scharpf, 1997). These rules are often shaped over time and might be different among markets and cultures. Current players might want to keep the status quo and design blockchain applications in such a way that it matches current governance and rules, whereas new players might shape blockchain applications in radical new ways which might disrupt the existing markets.

The institutional dimensions are used to categorize the factors that place a demand upon the blockchain technology design or are affected by the blockchain application. Although the core of blockchain is at the technology level, it is disruptive and therefore changes the institutional level.

3.1.1. Norms and culture

In order to be adopted, blockchain technologies need to overcome cultural resistance by market incumbents (Buehler *et al.,* 2015; Crosby *et al.,* 2016; Shackelford and Myers, 2016). Additionally, resistance to change of both, customers and companies, can affect adoption of blockchain technologies. Customers will need to get used to the fact that all their electronic transactions are more secure, complete and safe. Intermediaries (for example payment providers such as Visa and Mastercard) will need to go through change of responsibilities and roles. They will need to invest and modify their platform to become block-chain based, whilst continuing to provide services and further customer relationship (Crosby *et al.,* 2016). On the other hand, new players enter the field who take a different approach and as entrants might be threatening for existing players. The current players benefit from their existing customer base, however, path dependencies might slow-down the speed of progress.

New players entering the market do not have these path dependencies, but need to acquire a new customer base.

It is reiterated by multiple sources that there is a lack of understanding among business, consumers and authorities regarding the potential use cases for Blockchain, the ways in which it operates and what the technology can actually do (Andreasyan, 2016; Brandman and Thampapillai, 2016; Buehler *et al.,* 2015; Deloitte, 2016; Deshpande *et al.,* 2017; Parliamentary Office of Science and Technology, 2016; SWIFT Instittude, 2016). Furthermore, the decentralized, possible transparency and accountability created by the technology can create new settings where individuals can be less dependent on controlled, sometimes inefficient, services offered through associated and intermediary service providers (Al-Saqaf and Seidler, 2017; Vranken, 2017). Hence, it is necessary to understand how this innovative technology can be integrated within businesses strategies and individuals' activities in order to understand its societal impact (Marsal-Llacuna, 2018).

3.1.2. Regulations and legislation

One important challenge of blockchain technology is the way they are going to be regulated, bearing in mind that a technology, by definition, is not the subject of regulation, but it is rather the different uses of the technology itself which may call for regulatory constraints. In the case of blockchain, the use could be in cryptocurrencies, distributed ledgers or smart contracts (Cermeño, 2016). In particular, the regulation of blockchain-based digital currency (cryptocurrencies) has gained attention, whereas other applications have yet to gain the attention of regulators.

The adoption of blockchain can be slowed down by government agencies or certain applications might even be blocked. For example, the Federal Trade Commission (FTC) and the Securities Exchange Commission (SEC) are evaluating whether a need exist for the introduction of new laws. New laws and regulations could be considered in order to monitor and regulate the industry for compliance (Crosby *et al.,* 2016). In certain countries such as Bangladesh, Bolivia, Ecuador and Nepal, cryptocurrencies are forbidden (Sedgwick, 2017). Policymakers and regulators on a global scale are focusing mainly on regulating the use of cryptocurrencies to avoid taxation and criminal activities (Cermeño, 2016). While some countries consider cryptocurrencies as digital money, others treat them as commodities. In this respect, in 2015, the European Court of Justice (ECJ) ruling identified cryptocurrency transactions to be exempted from VAT and treated cryptocurrency as money or currency (Court of Justice of the European Union, 2015). In this context, laws and regulations can influence how fast the blockchain technology could develop. Yeoh (2017) claimed that there are challenges to wider blockchain adoption despite the opportunities it offers. The author argued that blockchain relies on collaborative governance to provide trust in markets to ensure that all stakeholders play by agreed rules. The absence of such governance is the main reason behind the blockchain cybercrime and other criminal activities. Such governance with policies, procedures and mechanisms and enforcement is needed to realize the real societal benefits of blockchains. Regulations and technology support will need to be introduced in order for law enforcement agencies to be able to monitor and prosecute individuals engaging in fraudulent activities such as money trafficking (Crosby *et al.*, 2016).

Regulation concerns laws that are designed to control behaviour, while governance concerns stewardship, collaboration and incentives to act on common interests. In this respect, governments should regulate technologies such as blockchain and at the same time function as a collaborative peer to other constituents of society rather than as the heavy hand of the law (Tapscott and Tapscott, 2016). This can be done by participating as players in a bottom-up governance ecosystem instead of as enforcements of top-down regimes of control (Yeoh, 2017). Several studies have proposed that in order to avoid misuse of blockchain technologies such as black-market transactions, tax evasion, money laundering and terrorist financing, a legal framework as a practical guide for policymakers should be created (ESMA, 2017; Kiviat, 2015; Yeoh, 2017). Policymakers will need to revisit regulatory frameworks such as banking laws, commodities laws and securities laws to incorporate the blockchain technology into existing frameworks (Kiviat, 2015).

According to Cermeño (2016), there are six regulatory/legal challenges to overcome before blockchain technology can be used: legal nature of blockchain and distributed ledger; recognition of blockchain as immutable, tamper-proof sources of truth; right to be forgotten; legal validity of documents stored in the blockchain; validity of financial instruments; and using smart contracts. Legal challenges posed for regulators should take into consideration factors which could affect adoption of blockchain. In order for blockchain technology to be widely implemented, legislation laws should be rewritten or amended to take into consideration the nature of blockchain technology. Also, issues such as data security should be addressed as a topic of growing importance. Decisions such as where the data is physically held will need to be answered by regulators (Harwood-Jones, 2016).

Finally, the perception of blockchain technology influences the views and opinions of public, policymakers and regulators, who connect and identify it (mistakenly) to Bitcoin and as a result connect wild price swings, fraudulent investment schemes and multimillion dollar hack events associated to some cryptocurrencies (such as Bitcoin) to the underlying technology (blockchain) (Kiviat 2015; Yeoh, 2017). Bitcoin is often perceived as a venue for money-laundering, drug related activities and other related illegal activities. Additionally, the public perceives that Bitcoin mining is a substantial waste of energy (Vranken, 2017). Given such concerns and as in the case with many other technologies, blockchain can be used in good and bad ways, and according to Swan (2015), the benefits of using blockchain technologies outweigh the potential negative sides. Blockchain should certainly not be identified exclusively with Bitcoin, since, as we have discussed before, blockchain can be used for applications other than cryptocurrency, with Bitcoin being just one of many embodiments of a cryptocurrency, with other implementations often not having the drawbacks associated with Bitcoin.

3.1.3.Governance

Blockchain needs to be governed but it is also a governance instrument in itself (Ølnes *et al.,* 2017). In order for blockchain technologies to be adopted, market participants should put in place appropriate governance frameworks, which include provisions on the liability of the respective parties, rules to approve/reject authorised participants, correction mechanisms, applicable law in case of disputes etc. Additionally, these governance frameworks should be tailored to the functions and features of blockchain technologies (ESMA, 2017).

Governance should also mitigate risk of market manipulation and unfair practices. Due to the absence of proper safeguards some could get an access to information recorded in blockchain and use it for unfair activities such as front-run competitors or manipulation of prices. As a result, there should be a clear balance between level of transparency and the need to protect sensitive information through privacy rules (ESMA, 2017).

3.2 Market factors

The market factors refer to the operating of an organisation in its environment. Organisations operated in a type of market structure and make contracts to buy and sell products and use their business processes to create value. Blockchain can change the very nature of the way transactions are handled which influence the market structure. In particular, the role of intermediaries within a market structure is challenged in the literature.

3.2.1. Market structures

Adoption of blockchain technology requires a high degree of computerisation. Thus, some countries (e.g. developing or least developed) are not ready to participate in blockchain based solutions (Kshetri, 2018). Since blockchain technology requires distribution of data across different nodes it increases the magnitude of the issues to be considered due to the high bandwidth, storage demand and processing power required to be an active node. This could lead to a situation when some groups and regions will not be able to enjoy the benefits of blockchain technology for national services (Al-Saqaf and Seidler, 2017).

Blockchain based technologies also hold promise to disrupt the structure and resilience of financial markets. A 2017 report from the European Securities and Markets Authority, highlighted benefits as well as potential risks of Digital Ledger Technologies (DLTs) for applications in financial markets, in particular the possibility of increased market volatility, and the still controversial role that smart contracts could play if the size of blockchain based securities asset base were to grow, due to their embedded automated triggers which can provoke one-directional market reaction in time of stress. Also, interconnectedness between market participants can potentially increase due to the adoption of blockchain, although respondents also argued that

DLT technology can in principle help decrease interconnectedness as well as spot volatility drivers. Shorter settlement timeframes enabled by efficient DLT might however have an impact on liquidity (ESMA, 2017).

3.2.2. Contracts and agreements

Moving existing contracts to the new blockchain technology can lead to the need to migrate existing documents or contracts to the equivalent blockchain form (Crosby et al., 2016). Currently there is a lack of clarity regarding smart contracts which restrict them to simple agreements. Smart contracts are defined as "computer protocols that facilitate, verify, execute and enforce the terms of a commercial agreement" (Swanson, 2015, p. 15). For example, in agreements there is minimal subjectivity on fulfilment of terms (e.g. whether the contract is fulfilled or not). The majority of people think that a smart contract refers to an e-contract, which is a digital version of a contract that used to be a paper version (Deshpande *et al.*, 2017; Mainelli and Milne, 2016). Yet, the rules of a smart contract is embedded in software. Once the information is added and there is consensus among parties that the conditions are met the contract will automatically be executed. For a smart contract to be executed, the agreement will need to be self-monitoring and self-enforcing through a combination of scripting, systems set up to monitor off-blockchain information and data that is essential to the effective execution of the smart contract's terms. All of it will pose significant programming challenges (Kivat, 2015).

3.2.3. Business processes

Traditional business processes might not seem to be applicable for using blockchain as this technology is based on the "cutting the middle man" principle, thereby avoiding intermediary transaction fees (Swan, 2015). The costs of adoption and implementation of blockchain technologies for existing business in the short run can be very high, especially for incumbents with large existing back-office processes, complex legacy IT systems, processes created in order to be aligned with existing standards which could need expensive redesign. Removing or replacing some back-office processes with blockchain technologies can create problems (Deshpande *et al.*, 2017).

3.3 Technical factors

Most of the extant literature focuses on the technical aspects. Blockchain technology can take various shapes and the design choices determines its benefits (Ølnes *et al.*, 2017). A typology is based on private or public closed blockchains (termed as a private/public permissioned blockchain) and private or public open blockchains (termed as a permissionless blockchain) (Mainelli and Smith, 2015).

3.3.1. Information exchange and transactions

Time needed to process transaction can be another challenge for the adoption of blockchain technologies. The time to process transaction for a Bitcoin network is only one transaction per second (tps), with a theoretical current maximum of 7 (tps), which is small in comparison with other transaction processing networks such as VISA (2000 tps typical, 10000 tps peak), Twitter (5000 tps typical; 15000 tps peak), and advertising networks (>100000 tps typical). In order to overcome this limitation, the size of each block should be increased. However, this will lead to other issues such as size and blockchain bloat (Swan, 2015). In terms of time, current processing time of one Bitcoin block is 10 minutes, which means that it will take minimum 10 minutes for transaction to be confirmed, when for VISA it takes just a few seconds. However, for large transactions it will take even longer as it must outweigh the cost of a double spend attack (the same coins are spent multiple times) (Swan, 2015). The current size of a blockchain of Bitcoin is 160GB (Blockchain, 2018) and it already takes a long downloading time. If processing speed is increased to 2000 tps (VISA standards) it would be 1.42 PB/year. As a result, it will lead to the problem, which is referred to as "bloating" (Swan, 2015).

Another challenge blockchain technologies face is that of scalability. As the transactional volumes required by services such as T2S is higher than Bitcoin transactions, the blockchain is not mature enough to deal with it at the current stage (Harwood-Jones, 2016). Therefore, the degree of challenge will depend on the applications. For instance, for relatively low market segments (e.g. bank loan securities) it will be less of a challenge, while scalability will play a very important role for high volume products (e.g. listed securities) (ESMA, 2017).

3.3.2.Distributed ledger

The distribution of access and management across numerous nodes can lead to a security risk, as there are multiple "back doors" through which the system can be attacked (ESMA, 2016a; b). Since companies in most networks run the same code (Knight, 2017), if hackers find a vulnerability, the entire system may face serious consequences (Kshetri, 2017). As a result, ensuring integrity of other users in the distributed ledger and running transactions in a consistently secure way are the key challenges to a wider adoption of blockchain technologies (Brennan and Lunn, 2016; Christidis and Devetsikiotis, 2016; Deshpande *et al.*, 2017). Additionally, there is a need for companies to think about integrity and security of data which is stored on a ledger (Deshpande *et al.*, 2017; ESMA 2016a, 2016b; Mainelli and Milne, 2015; Mills *et al.*, 2016). As for many ledgers, a transparent record may be preferred and when implementing blockchain technologies companies need to ensure that data can be accessed only by those individuals who have appropriate permissions (Deshpande *et al.*, 2017; Mainelli and Milne, 2016). Also, individuals generally do not feel comfortable storing their personal records in a decentralised manner. If personal records are stolen the implications can be significant for individuals (Swan, 2015).

Although the use of a distributed ledger is a way to avoid unseen manipulation, it is crucial for blockchain technology systems to have cyber-protection in place, as cyber-crime is a high-level concern for all market participants. The fear of cyber-activities could prevent adoption on blockchain for different industries. Even though proponents of the technology argue that blockchain has increased cyber-security, testing on a wider scale is a key requirement within a highly regulated environment (ESMA 2017; Harwood-Jones, 2016).

Another concern is the newness of blockchain technology. Since blockchain can considered to be in its infancy, some information systems do not have well developed security mechanisms. It is suggested that 1000 lines of code will have between 15 to 50 defects (Kshetri, 2017). Kshetri (2017) argues that as blockchain has not yet been used widely enough it has not been seriously tested to be error free. Deshpande *et al.* (2017) confirms that the perceived immaturity of technology creates challenges for companies which potentially want to implement blockchain technology.

3.3.3. Shared infrastructure

Another challenge of adopting blockchain is the need to have shared infrastructure which can provide the entire value chain of service delivery, such as secure decentralised storage, messaging, transport, communications protocols, address management, network administrator and archival (Swan, 2015). Swan posits that it is important in the blockchain economy to develop standard infrastructure components in order for industry to focus on the higher level of developing value-added service instead of focusing on core infrastructure. As blockchain economy has the complicated and sensitive engineering aspects of decentralised networks, it is important to have a secured and well-developed infrastructure (Swan, 2015).

At the current stage, the literature highlights that blockchain technology lacks standardisation on different levels which ranges from technical protocols to smart contracts (ESMA, 2017; Ølnes *et al.*, 2017). Development of blockchain was not connected with existing business standards organisations such as ISDA (International Swaps and Derivatives Association), FPL (FIX Protocol Ltd), or ISO (International Organisation for Standardisation). As a result of this lack of standardisation, different blockchains are not interoperable and stored information is not in line with market standards and practices (Harwood-Jones, 2016). Adoption of blockchain technology will require harmonised technology standards and the use of a universal standard for reference data (ESMA, 2017).

Table 1 presents the summary of factors affecting the adoption of blockchain technologies as discussed above.

Table 1. Summary of main factors affecting adoption of blockchain technologies

Factors affecting adoption of blockchain technology	**Challenges**	**References**
Institutional factors		
Norms and cultures	▪ Cultural resistance ▪ Resistance to change ▪ Lack of understanding of blockchain technology	Al-Saqaf and Seidler, 2017; Andreasyan, 2016; Brandman and Thampapillai, 2016; Buehler et al., 2015; Crosby *et al.*, 2016; Deloitte, 2016; Deshpande *et al.*, 2017; Euro Banking Association Working Group On Electronic Alternative Payments, 2016; Marsal-Llacuna, 2018; Parliamentary Office of

		Science and Technology, 2016; Shackelford and Myers, 2016; SWIFT Institute, 2016; Vranken, 2017
Regulations and legislations	▪ The need of introduction of new law ▪ Ability of law enforcement agencies to deal with fraudulent activities ▪ Confusion of policymakers Bitcoin with blockchain technology ▪ Need to deal with taxation ▪ Laws should take into consideration the nature of blockchain technologies	Cermeño, 2016; Crosby *et al.*, 2016; ESMA, 2017; Harwood-Jones, 2016; Kiviat, 2015; Swan, 2015; Tapscott and Tapscott, 2016; Yeoh, 2017
Governance	▪ Government losing control ▪ Using appropriate governance framework ▪ Risk of market manipulation and unfair practices	ESMA, 2017; Swan, 2015
Market factors		
Market structure	▪ High degree of computerisation increases in market volatility ▪ Interconnectedness	Al-Saqaf and Seidler, 2017; ESMA 2017; Kshetri, 2018
Contracts and agreements	▪ Moving existing contract to new blockchain technology methodology ▪ Lack of clarity on smart contracts ▪ Confusion of smart contracts with e-contracts	Crosby *et al.*, 2016; Deshpande *et al.*, 2017; Kiviat, 2015; Mainelli and Milne, 2016
Business process	▪ Inability to apply traditional business processes for using blockchain technology ▪ Cost of adoption and implementation of blockchain technology for businesses	Deshpande *et al.*, 2017; Swan, 2015
Technical factors		
Information exchange and transactions	▪ Time to process transaction ▪ Size of the block ▪ Scalability ▪ Standardisation	ESMA, 2017; Harwood-Jones, 2016; Swan, 2015
Distributed ledger	▪ Design of the system ▪ Cybercrime ▪ Newness	Brennan and Lunn, 2016; Christidis and Devetsikiotis, 2016; Deshpande *et al.*, 2017 Swan, 2015; ESMA 2016a, 2016b, ESMA 2017; Harwood-Jones, 2016; Knight, 2017; Kshetri, 2017; Mainelli and Milne, 2015; Mainelli and Milne, 2016, Mills *et al.*, 2016
Shared infrastructure	▪ Development of standard infrastructure components	ESMA, 2017; Harwood-Jones, 2016; Ølnes *et al.*, 2017; Swan, 2015

4. Conceptual framework for analysing blockchain technology

There is a need for an integrated understanding of the various factors ranging from governance to technology to create blockchain applications that work, fulfil the benefits of users and service providers and are acceptable by the society. Complex socio-technical infrastructures can be analysed at different levels, like culture, laws and regulations, contracts which guide and coordinate the behaviour of actors and the technology. Williamson (1998) developed an institutional framework to understand the factors of changes and provide four levels; namely social embeddedness, institutional environment, governance and resource allocation levels. The levels at the top of the framework takes longer to change than the aspects included at the levels at the bottom. The levels are connected with and dependent on each other. With blockchain technology, the time period of change is shortened in comparison to development of applications in the past. This is one of the key reasons why blockchain is called a disruptive technology. Koppenjan and Groenewegen (2005) added process and technology components to this framework. Process refers to the changes needed and how they are managed. Based on this, the authors of this research, developed the PIMT (Process, Institutional, Markets and Technology) framework for blockchain technology adoption.

The process contains the strategies and change management instrument to ensure long term change. The institutional level refers to the changes needed in norms and culture (i.e. digitalization as default for transactions, the need for legislation to enable blockchain, but also to limit its application to make the societal acceptable, and the governance guiding the market). The next layer is the market and to examine which market structure is changing due to blockchain technology. New contracts and agreements need to be developed within the new legislative framework developed at the institutional level. The business process contains the activities and the responsibilities for operation. The technology level contains the design of the software making use of a variety of technologies (identification, cryptography, distributed ledger etc). This contains the information exchange and actual transactions which are stored in distributed ledgers and operated on (shared) infrastructure.

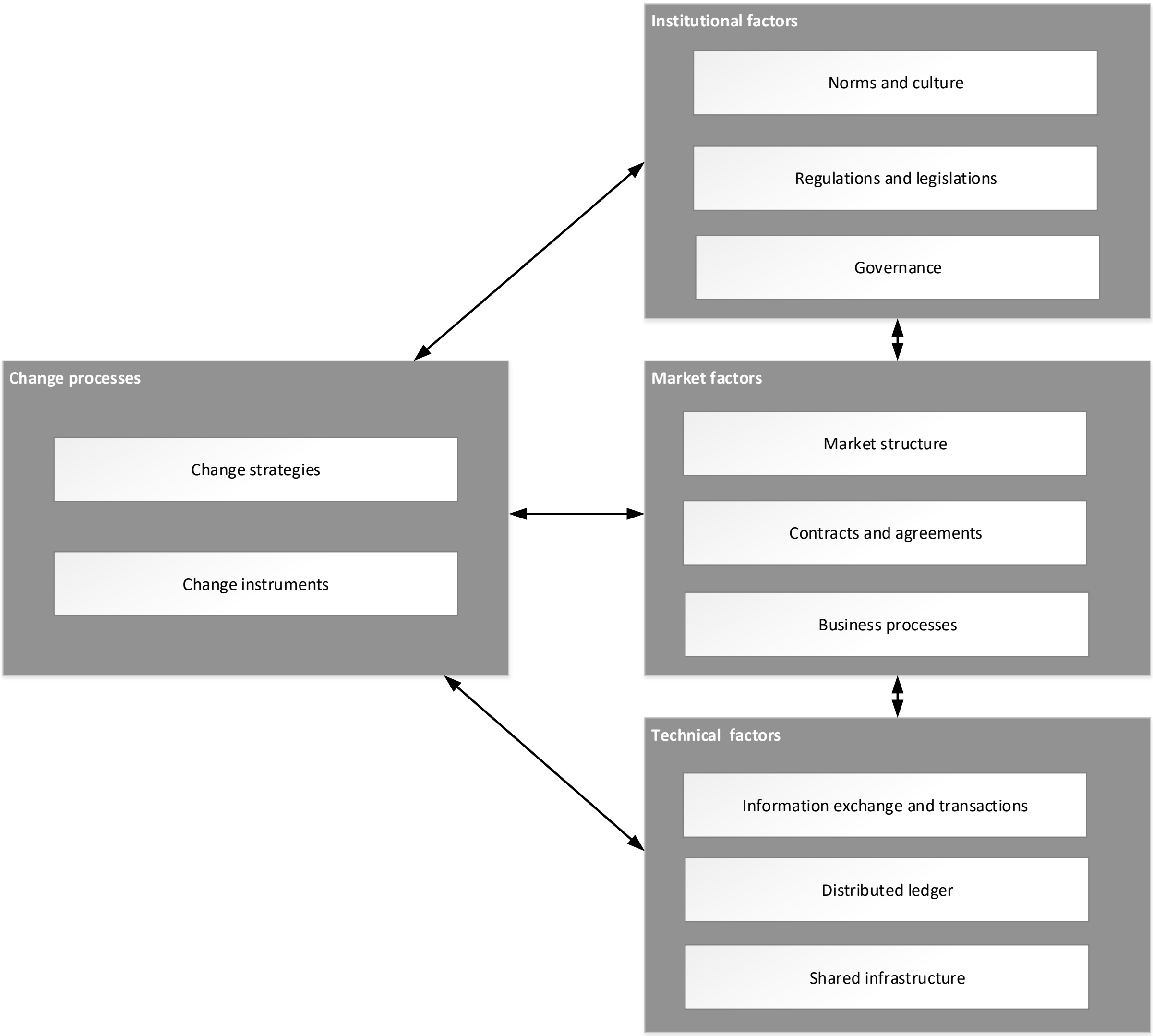

Figure 1: Integrated Process, Institutional, Market, Technology (PIMT) Framework for Blockchain Adoption

The PIMT framework proposed in figure 1 is the first comprehensive conceptual framework providing an overview of factors and their relationships when considering blockchain adoption. The framework can be used for organizations to understand the broader scope of blockchain technology. It draws the need to understand the institutional and organisational aspects which shape the way blockchain applications are implemented and how blockchain applications can change or even disrupt current markets and structures. This draws the need to understand the interaction among the factors and the materiality during the change process which ultimately shapes the use of blockchain technology. Furthermore, the framework can be used by organizations to adopt blockchain applications. Although blockchain applications are at the technology level, adoption requires the changing of organization processes and the introduction of new governance mechanisms. The framework can be used to understand the broader implications of adoption.

5. Conclusions

Being a type of decentralised transaction and data management technology, blockchain technologies provide trust, anonymity, security and data integrity without having to use any third party controlling organization. A review of the limited literature reveals that most of the studies on adoption of blockchain technologies primary focus on technological aspects. However, as discussed in this paper, a much more holistic view is needed for organizational adoption. Majority of the existing studies on blockchain focused on the finance industry, which limits the application of findings for other industries. The literature review of this study presented the state of current knowledge in the adoption of blockchain technologies without limiting it to the particular context and helped to identify three groups of factors, namely institutional (norms and culture, regulations and legislations, governance), market (market structure, contracts and agreements, business process) and technical (information exchange and transactions, distributed ledges, shared infrastructure). The categorisation of the factors was based on the work of Koppenjan and Groenewegen (2005) leading to the proposed framework for analysing blockchain adoption. This is the first comprehensive framework integrating a range of factors for understanding the adoption of blockchain. The framework shows that different outcomes are possible and the change process is important as this shapes the form blockchain applications take. Factors presented in this framework (institutional factors, market factors and technical factors) interact and mutually influence each other. The way how different factors will interact with each other depends on the context in which blockchain will be adopted. Additionally, factors which influence the adoption of blockchain technologies depend on its intended use.

How the change process is managed within organisations and markets will shape the future adoption of blockchain. Although, many initiatives are technology oriented, the disruptive nature of blockchain impacts mainly the institution and organizational level. The proposed framework shows the relationship between the elements and we recommend more research to understand these relationships. There are many dependencies among factors. The experiences with cryptocurrencies shows that there are many ways to shape cryptocurrencies and institutional factors such as regulations will become highly influential in the evolution of blockchain adoption. While this was clear, there was limited discussion about some of the other institutional, market and technical factors in the extant literature. Therefore, we recommend more research to study the influence of each of the factors identified.

It is clear from the literature review conducted in this study that the use of blockchain is still nascent and evolving. Like many other technological concepts, the hype around blockchain has superseded the potential benefits, opportunities, costs and risks it poses to organisation and markets. This study has only synthesised the main factors as reported in the present literature from around 2015 to 2018 - majority of the articles being descriptive and secondary in nature. Yet, based on the number of factors identified in the study, the angles of inquiry need to be multiple. In this respect, blockchain adoption can draw from the multitude of previous technology influenced change studies that use institutional, market oriented and technology adoption lenses as the basis for conceptualising disruptive innovations and technologies. Therefore, research into blockchain requires a comprehensive interdisciplinary effort and our systematic review of literature using all the main reference sources (Web of Science, Business Source Complete, Scopus and Google Scholar) that in depth research into blockchain adoption is still to be undertaken.

This study has some limitations which future research can address. The main focus of the proposed framework is the adoption of blockchain technologies by organisations. Future research can focus on citizens adoption of blockchain technologies. Additionally, this is a theoretical framework and it has not been empirically tested. Future research needs to test the proposed framework in different contexts. The present study identified factors which affect adoption of blockchain, future research is still needed to provide solutions to these challenges. The proposed framework, based on literature, shows the interrelationship between factors and offers companies an initial frame of reference when adopting blockchain applications. Future research should explore, refine and test these relationships and expand the framework based on practical evidence.

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