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BLOCKCHAIN ADOPTION: TECHNOLOGICAL, ORGANISATIONAL, AND ENVIRONMENTAL CONSIDERATIONS

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Abstract: Information technology (IT) innovation is rapidly reshaping organisations, affecting fundamental aspects of their everyday business activities and processes. This development is accompanied by benefits as well as challenges. In this article, we focus on a specific distributed ledger IT called blockchain which has been heralded as possessing the capability to radically transform a multitude of industries. However, there is a dearth of research which has coalesced the important considerations that organisations should consider prior to adopting blockchain technologies. Consequently, using innovation theory, which has been extensively used to examine the adoption of IT in organisations, we identify salient technological, organisational and environmental (TOE) considerations which influence the adoption of blockchain by organisations. We anchor our discussion using the top three organisational considerations which emerged from our research: top management support, organisational readiness, and organisational support. We also provide an overview of the blockchain concept and outline the advantages and potential use cases that organisations contemplating adopting the technology can leverage.

Keywords: Blockchain, Organisational Adoption, Innovation Theory, Blockchain Benefits, Blockchain Use Cases, TOE Considerations.

Introduction

“Change is inevitable...progress is optional.” John C. Maxwell

In the past decade, distributed ledger technologies (DLT) have revolutionised approaches to decentralised decision making. Instead of keeping data centralised in a traditional ledger, DLT encompasses the use of independent computers, often referred to as “nodes”, to record, synchronise and share individual transactions in their respective electronic ledgers. Blockchain is one example of a DLT. Transactions can include the exchange of data (e.g., personal identification records) and assets (e.g., tokens, digital currency). Blockchain is a digital ledger which allows for the brokering of trust on a decentralised peer-to-peer network. Blockchain first came to prominence in 2008 as the technology which underpinned the Bitcoin cryptocurrency (Nakamoto, 2008). Blockchain, however, is a far more versatile technology! According to Ito et al., (2017), blockchain is anticipated to disrupt a multitude of industries (e.g., health, food, financial, government) in the next decade. Blockchain provides adopters with advantages such as anonymity (Zyskind, Nathan and Pentland, 2015); immutability (Pilkington, 2015); transparency (Kosba, et al., 2016); security (Mendling et al., 2017) and fast transactions (Kiayias and Panagiotakos, 2016). In 2018 the global blockchain technology market is predicted to reach 548 million U.S. dollars in size and is forecast to grow to 2.3 billion U.S. dollars by 2021 (Mehta and Striapunia, 2017). Although the global blockchain adoption rate is increasing gradually, as reported by IT analysts such as McKinsey (2017) and Accenture (Treat et al., 2017) and multinational technology company IBM (Bear et al., 2016) the adoption rates in developed countries appear to be rather low. Motivated by blockchain’s potential to transform sociotechnical systems, the lack of systematic inquiry pertaining to blockchain adoption, we propose the following research question:

What significant technological, organisational and environmental considerations influence blockchain adoption in organisations?

To investigate this research question, we operationalised innovation theory, which has been extensively used to examine information technology (IT) innovation adoption in organisations (Rogers, 1995; Yu and Hang, 2010; Van de Weerd, 2016). Consequently, we conducted a comprehensive review of the blockchain literature using the technology, organisational and environmental (TOE) framework (Tornatsky and Fleischer, 1990) to identify significant considerations which influence blockchain adoption in organisations.

This article is structured as follows. The next section provides an overview of the blockchain concept and outlines the benefits associated with the technology. Next, we introduce our research approach. Then, the findings from our study are delineated. Finally, we discuss our findings, the study’s implications and limitations and present our conclusions.

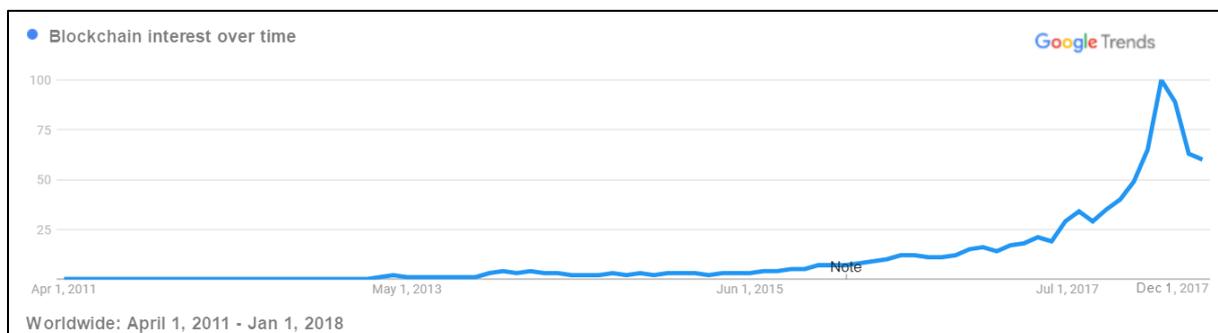
The Blockchain Concept

This section will firstly provide an overview of the blockchain concept. Next, we discuss the benefits that can be derived from adopting blockchain technologies. Then, we provide an overview of the TOE framework which we used as a lens to investigate our research question.

The new technology kid on the block

In the past, commerce on the internet has relied solely on trusted third parties, such as financial institutions, to process any electronic payments. However, in 2008 the introduction of Bitcoin led to a paradigm shift in how transactions are processed worldwide (Nakamoto, 2008). Although often going hand-in-hand, many believe that the success of Bitcoin is not in the service it offers, but in the underpinning technology; Blockchain (Ross, 2017). As can be seen in Figure 1, the term ‘blockchain’ peaked in December 2017 (Google, 2018). This peak coincided with the increasing price appreciation for the bitcoin cryptocurrency whose price index reached an all-time high of \$19,783.21 on December 17, 2017. Blockchain is defined as an open-source dataset, distributed across millions of computers, utilising avant-garde cryptography (Tapscott, Tapscott and Kirkland, 2016). Ultimately, blockchain is a secure, decentralised, public ledger, in which every person can view the transaction history in totality, removing the need for a trusted third-party (Pilkington, 2015).

Figure 1. Google Trends result for the search term ‘blockchain’ (Google, 2018)



Using Bitcoin as an example, we will now provide an overview of how blockchain technology works. Each block in the chain is an acknowledgement by network participants that the transaction took place and was not fraudulent. Each block contains information from the previous block, thus ordering chronologically, creating a chain of blocks (Nakamoto, 2008). To add a block to the chain, it is necessary to solve a cryptographic puzzle, with the solution being included in the block (Wright and De Filippi, 2015). It takes the approximately 10 minutes for the entire network of miners to solve this cryptographic puzzle (Ito, Narula and Ali, 2017). The new transactions must be verified by most users before being added to the ledger. This operation results in approximately a one-hour processing period, which is still a significantly shorter period than that of current financial institutions.

However, solving this puzzle takes specially created computers and consumes vast amounts of energy; hence this task is usually completed by miners. Miners are participants in the blockchain network that solve cryptographic puzzles in the hope of being the first to do so. If the miner is successful in solving the puzzle, they will be awarded 25 Bitcoins. This value halves periodically, as a maximum number of Bitcoins of 21 million has been assigned to control inflation (Nakamoto, 2008; Vlasov, 2017). Eventually, miners will not be awarded any coins for their work. This design could potentially result in network users refusing to mine cryptographic puzzles, as the cost of doing so is too high. To overcome such an issue, it is possible for the payer to assign a reward to the puzzle themselves, to encourage miners to work on this puzzle promptly. This is usually 1 micropayment, called a Satoshi, or 0.00000001 Bitcoin (Ron and Shamir, 2012). In the future, when the maximum limit of 21 million Bitcoins is reached, the rewards of such Satoshi's will be the only incentive for miners (Nakamoto, 2008).

Proof-of-work is a key component of this system. As the decision of adding a block to the chain is a majority vote, it was important to decide what type of vote users would have.

Instead of one-IP-one-vote systems, blockchain votes are determined by the pool operator and application specific integrated circuits (abbreviated as ASICS) in large mining pools.

This proof-of-work method ensures that the majority vote will always lie with the longest chain, as it has the majority of the computing power invested in it (Nakamoto, 2008).

Suggestions have been made in the past about substituting proof-of-work for a proof-of-stake method, which splits the blocks proportionally to miners' wealth. It is suggested that this new method would increase the speed of blockchains, as well as reduce the chance of 51% attacks. At the same time though, this new method has not been incorporated into blockchain

technology, which has remained unedited since its outset (Pilkington, 2015; King and Nadal, 2012).

Blockchain Benefits

Blockchain is anticipated to be a core foundational technology spanning multiple industries in the next ten years (Ito et al., 2017). This success of blockchain technology is down to its inherent characteristics and the benefits it provides to its users which include:

Anonymity

Anonymity is a key feature of this infrastructure which attracts individuals and organisations alike to implement it (Zyskind, Nathan and Pentland, 2015; Reid and Harrigan, 2012).

Blockchains allow users to only be identified by public keys, an essential element of the cryptosystem. It is encouraged that users generate as many public keys as necessary, with some users creating a new key for each transaction (Nakamoto, 2008; Reid and Harrigan, 2012). This feature allows any person or organisation to transact any sum of money to any place in the world, with no government intervention, and extremely low transaction costs. This has seemed to attract many multinationals to the technology, with blockchain firms receiving \$1 Billion in investment from global companies such as American Express, Deloitte, Goldman Sachs and the New York Stock Exchange (Crosby et al., 2016).

Immutability

Immutability is a fundamental characteristic of blockchain and has been identified repeatedly as one of the reasons of its success thus far (Pilkington, 2015; Tapscott, et al., 2016; Iansiti and Lakhani, 2017). By virtue of its design, changing one block in the chain would involve changing each subsequent block, as each block contains information of the previous (Nakamoto, 2008). This is infeasible to the linear rate at which the chain expands, with new blocks being issued approximately every ten minutes (Böhme, et al., 2015). Although this is seen widely as a strength, it could also be considered a disadvantage as it also means that it would be impossible to edit an entry to the chain, for example, to carry out a remedy or refund (Surujnath, 2017). However, the majority believe this is a leading attribute of the system, redefining trust, not in people but in the mathematics behind the technology (Underwood, 2016; Nofer et al., 2017).

Transparency

Blockchains can be categorised as being private or public. The sole distinction between a private and a public blockchain is that in a private blockchain context, also referred to as a permissioned blockchain, access to the network is restricted (e.g., an access restricted platform controlled by a commercial entity, a private equity tracking tool for private equity agreements etc.). Conversely, public blockchains are a completely transparent distributed ledger, with all the users in the network being able to view all transactions that have occurred (Nakamoto, 2008; Underwood, 2016; Kosba, Miller, Shi, Wen, Papamanthou, 2016). The allowance for all users to view previous transactions is largely linked to the immutability factor, thus protecting the chain from alterations and tampering (Iansiti and Lakhani, 2017). Although it is argued that the lack of privacy could be considered an issue for some users, the transparent nature of the system has been more widely commended than not (Kosba, et al., 2016). With multinationals like Deloitte, JP Morgan and Chase and Goldman Sachs investing in blockchain, it may soon become apparent if the transparency of their financial activities is less advantageous as initially thought (Garrod, 2016). Blockchain technology has been proven to show characteristics of a disruptive technology, with many applications of the infrastructure being suggested. There has been considerable debate in the technology field as to whether blockchain technology can survive as its own entity, with many experts believing that it will not survive without a monetary value (Pilkington, 2015). However, with many potential uses of such a concept, it is unlikely that it will only be utilised in the financial industry. The following are examples of potential blockchain use cases.

Blockchain Use Cases

Smart Contracts

The discussion of smart contracts was in existence long before the advent of blockchain, being first introduced in 1994 by Nick Szabo, however it is one of the most deliberated uses of the technology to date (Surujnath, 2017; Nofer et al, 2017, Kosba et al., 2016; Garrod, 2016; Wright and De Filippi, 2015). Smart contracts are defined as computer programs that automatically execute the terms of a contract, or contracts that are executed when user interfaces are combined with computer protocols (Crosby, et al., 2016; Nofer et al., 2017). It is now believed that Szabo's creative idea can turn into a reality as conducting smart contracts through a decentralised cryptosystem, it allows unknown and untrusted parties to transact securely, without the need of a third party (Kosba et al., 2016). Pilkington (2015) acknowledges the potential of the application of blockchain technology, discussing Ethereum

as a model featuring this idea, however the lack of transactional privacy has since been identified as a possible flaw to the implementation of smart contracts (Kosba et al., 2016). Potentially suitable contracts that could be created using blockchain include marriage contracts and transnational lending programs (Garrod, 2016). A number of risks are involved with the use of smart contracts, such as volatility creating possible market bubbles, as well as the lack of regulation, and the irrevocability of agreements (Piazza, 2017). In contrast to this, the risks incurred by smart contracts are greatly reduced in comparison to traditional because they are autonomous, self-sufficient and decentralised (Ross, 2017). Because of smart contract's infancy, the advantages and disadvantages may not be clearly defined yet (Surujnath, 2017).

Supply Chain Management

It is often identified that supply chains are opaque to consumers, with it becoming increasingly difficult to identify where products originated and where they travelled to. Blockchain could be used in this instance as a transparent ledger that is available on each node and would create a formal log of tracking products in the supply chain (Pilkington, 2015; Iansiti and Lakhani, 2017). This idea of SCM through blockchain has been conceptualised by Walmart, who are employing the technology to track occurrences of bacteria in food and be aptly able to identify the source and limit the number of items needing to be recalled (Nofer, et al., 2017). It has also been implemented in the diamond industry to end unethical behavior (Nofer et al., 2017; Underwood, 2016).

Voting Systems

The contemporary concept can also be extended beyond financial circles into online voting systems, as the anonymisation of data protects personal information, necessary for any voting technology (Zyskind *et al.*, 2015; Extance, 2015). By employing blockchain into voting systems, greater transparency would be in existence with each vote being accurately recorded (Pilkington, 2015). It has also been suggested that in addition to voting politicians into power, it could also be used to change votes in the event of a political scandal, resulting in a politician no longer having the majority vote (Wrights and De Filippi, 2015). A blockchain voting system was utilised by the Danish political party Liberal Alliance for internal elections in 2014 (Pilkington, 2015). In March 2018, Sierra Leone became the first country in the world to use blockchain to ensure trust and transparency in their presidential election process.

Each vote cast in the election, which was monitored by an independent foundation called Agora, was recorded on a private permissioned blockchain (Kazeem, 2018).

Micropayments

The use of blockchain technology is currently being incorporated into all Internet browsers and websites by expert programmers. However, it is feared that this may enable a ‘metered Internet’ in which micropayments may have to be paid (Wright and De Filippi, 2015). A micropayment is defined as a very small payment, and in terms of cryptocurrency, this would be a Satoshi, or 10^{-8} Bitcoins (Ron and Shamir, 2012; Hernandez, 2017). It should be noted though that as the value of Bitcoins increase, a Satoshi may no longer be considered a micropayment, and could potentially grow to be quite a large payment. This would be due to the volatility of the currency (Kiviat, 2015; Richter, *et al*, 2015). Micropayments would be most commonly sought after in relation to collecting royalties for musicians and artists for work distributed online (Wright and De Filippi, 2015). One artist that collects such payments is Imogen Heap from the United Kingdom, who uses blockchain to sell her music (Tapscott, et al., 2016). It has also been suggested that the implementation of micropayments would reduce the occurrence of spam mail, as each email would have a micropayment (Wright and De Filippi, 2015). Bitcoin has become increasingly competitive in micropayments, but there is no reason to believe that more mainstream organisations would not reduce transactions costs to compete in this industry (Grinberg, 2011).

Internet of Things

A suggested widespread utilisation of blockchain technology involves the Internet of Things (IoT) in which all communications of smart devices are stored securely (Nofer et al., 2017). IBM and Samsung have already created a washing machine that uses IoT and blockchain technologies to order its own detergent when it is low, showing that what began as an experiment is now globally recognised (Garrod, 2016). Blockchain enables IoT or smart devices to transact and communicate in real time, and with the rapid increase of ‘mobile wallets’, payments can be paid via mobiles (Wright and De Filippi, 2015; Ross, 2017). One suggested use of blockchain in IoT is as a settlement system. With millions of smart devices communicating and transacting with each other, it is not feasible for banks to process trillions of transactions in real-time, and blockchain will come in to play in these circumstances (Tapscott, et al., 2016). Although not widely implemented yet, the potential is promising.

The Adoption of Information Technology Innovations

Information technology (IT) innovations are now part of the popular business lexicon. Given the significant impact of IT innovations on organisations, IT innovation adoption has regularly been put under the spotlight over the past decades. There is a wealth of research demonstrating how IT innovations can influence every facet of a company and can lead to enhanced innovation, growth, performance, profitability efficiency and productivity (Barrett et al., 2015; Christensen and Raynor, 2015).

According to Rogers (1995, p.11), an innovation is “an idea, practice or object that is perceived as new by an individual or another unit of adoption”. Whereas innovation can allude to something abstract, like an idea, it can also manifest through new technology. An organisation’s decision to adopt an IT innovation can be conceptualised as “a decision to make full use of an innovative IT as the best course of action available” (Rogers, 1995, p.21). Many theories have been used to identify specific considerations that significantly or insignificantly impact the adoption of IT innovations in enterprises. Examples include the technology, organisational and environmental framework (Tornatsky and Fleischer, 1990), the perceived e-readiness model (Molla and Licker, 2005), the technology acceptance model (Venkatesh and Davis, 2000), assimilation theory (Armstrong and Sambamurthy, 1999) and theory of reasoned action (Ajzen and Fishbein, 1988). For the purposes of this paper, we used the TOE framework as a lens to investigate our research question.

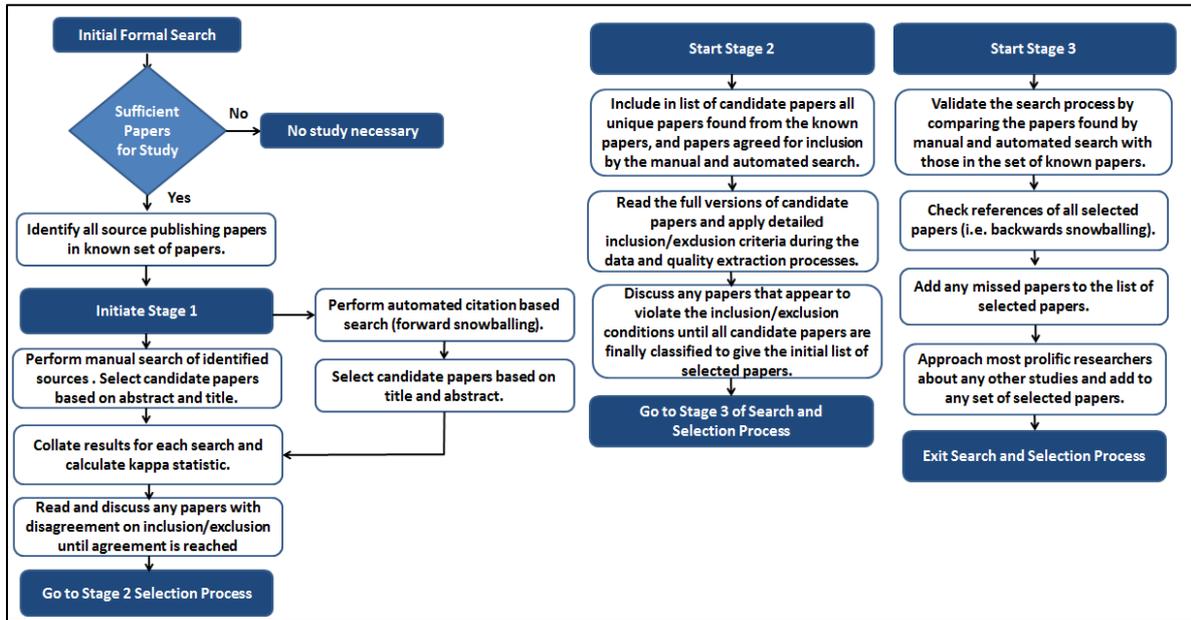
The main objective of the TOE framework (Tornatsky and Fleischer, 1990) is to identify technological, organisational and environmental views that influence the adoption of IT innovations in organisations. These views can provide barriers and incentives to IT adoption. The technological view encompasses technological considerations such as complexity, relative advantage, privacy, security and compatibility which can impact existing IT systems in use or the new IT being considered for adoption (Rogers, 1995). The organisational view refers to the internal considerations within an organisation such as prior IT experience, innovativeness, top management support, organisational size, information intensity and organisational readiness (Wang et al., 2010). The environmental view encompasses considerations which impact an organisation’s day to day business operations such as competitive and industry dynamics, government interactions, and regulation (Lippert and Govindarajulu, 2006).

Research Approach

Literature Review

The primary objective of our literature review was to analyse the extant empirical research on blockchain to identify significant technological, organisational, and environmental adoption considerations. An effective literature review not only makes a significant contribution to cumulative culture but also “creates a firm foundation for advancing knowledge. It closes areas where a plethora of research exists and uncovers areas where research is needed” (Webster and Watson, 2002, p.13). Our motivation was to produce a well-rounded understanding of blockchain adoption, which is currently lacking by carefully describing and then contrasting and comparing an array of sources on the topic. The first step in our analysis of the literature encompassed the sourcing of relevant research resources via scholarly databases and manual searches. To ensure the consistency and reliability of the search and data collection process we used a three-stage literature mapping protocol (see Figure 2) as prescribed by Kitchenham and Brereton (2013) to search, select, appraise and validate the literature. This mapping protocol ensured that we did not overlook relevant literature which may have been categorised under different headings. This protocol also helped the researchers to define the boundaries in which our review was conducted (e.g. inclusion and exclusion criteria). For the initial *stage 1*, we conducted a rigorous search of seven prominent databases to produce a research resource set which was representative of the status of personal analytics research: EBSCOhost, JSTOR, ProQuest, Google Scholar, PubMed, Scopus, and Web of Knowledge. We selected these specific databases because of the multidisciplinary nature of blockchain research. We used the search strings “blockchain” AND “adoption”; “blockchain” AND “TOE”; “bitcoin” AND “adoption”; “bitcoin” AND “TOE”. We included both theoretical and empirical studies and extracted significant considerations which influenced blockchain adoption.

Figure 2. Literature review mapping process. Adapted from Kitchenham and Brereton (2013)



Given the dearth of research pertaining blockchain adoption, grey literature research resources (e.g. conference proceedings, research reports, issue papers, white papers etc.) were also included. Inaccessible research sources were excluded in cases where the library did not access to a full-text version or where the library was not subscribed to a publishing resource. All research resources were imported directly into an EndNote database. Using EndNote’s ‘find duplication’ feature seventy duplicates were removed. The remaining research sources were further filtered using *stage 2* and *stage 3* of the mapping protocol. *Stage 2 selection processes* encompassed a decision-making process to include or exclude relevant research papers from the data extraction process. The “final decision took place when the research sources were read in parallel with data extraction and quality assessment. *Stage 3 search and selection* took place in parallel with data and quality extraction from the research sources identified in *stages 1* and *2* and comprised three main tasks: search process validation, backward snowballing and researcher consultation” (Kitchenham and Brereton, 2013, p.8).

Table 1 presents an overview of the final 16 research resources which we used to identify salient technological, organisational and environmental blockchain adoption considerations.

Findings

Table 1 delineates blockchain studies which outline significant technological, organisational and environmental considerations which influence blockchain adoption. Table 1 was created based on a comprehensive literature review (Kitchenham and Brereton, 2013). Table 1 enabled us to extract specific variables that were found to be significant in at least one of the studies, denoted by *. This process enabled us to then create Table 2 which provides a summary of the variables according to the number of times that were found to be significant.

Table 1. Significant blockchain adoption considerations

#	Author	Technological considerations	Organisational considerations	Environmental considerations
1	Wang et al., (2016)	Perceived benefits*, data security*, data integrity, complexity*, compatibility*, technology maturity*, uncertainty	Organisational size*, top management support*, organisational readiness*, responding capability	Regulatory environment*, industry pressure*, market dynamics*
2	Lansiti and Lakhani (2017)	Relative advantage*, cost savings, complexity*, accessibility, trialability, compatibility*	Technology readiness*, organisational size*, top management support*, value chain readiness	Competitive pressure*, relationship with partners, government policy, business use cases*
3	Guo and Liang (2016)	Cost, data security*, privacy, relative advantage*, business concerns*, compatibility*, complexity*, disintermediation*	Organisational readiness*, top management support*, blockchain knowledge, information intensity	Market dynamics*, government support*, regulatory environment*, industry standards*
4	Crosby et al., (2016)	Perceived benefits*, complexity*, relative advantage*, privacy, data security	Customer relationship, top management support*, organisational readiness*, organisational size*	Government support*, regulatory environment*, competitive pressure*, trading partner pressure*
5	Swan (2015)	Complexity*, relative advantage*, data security*, privacy, disintermediation*	Technology readiness*, organisational readiness*, business model readiness*, relative advantage	Regulatory environment*, public perception of the industry standards*, market dynamics, government support*
6	Shrier et al. (2016)	Complexity*, relative advantage*, perceived benefits*, legacy infrastructure, compatibility*	Organisational readiness*, organisational size*, top management support*, employee disruption	Regulatory environment*, governmental support*
7	O'Dair et al., (2016)	Relative advantage*, perceived benefits*, complexity*, compatibility*, data governance, disintermediation*	Blockchain knowledge, organisational size*, organisational readiness*, business model readiness	Emergence of use case examples, government regulation*, market dynamics, critical user mass*
8	Folkinshteyn and Lennon (2016)	Data security*, privacy, perceived benefits*, disintermediation*, cost savings, continuity of service	Organisational readiness*, customer relationship, size, top management support*	Market dynamics*, trading partner support*, regulatory environment*
9	Tapscott et al., (2016)	Perceived benefits*, data security*, privacy, technology maturity*	Organisational readiness*, organisational size*, business model readiness*, blockchain knowledge*	Government support*, market standards, regulatory environment*
10	Mendling et al., (2017)	Data security*, latency, throughput, usability, hard forks, wasted resources	Organisational readiness*, organisational size*, governance, business models, top management support*	Regulatory environment*, market dynamics, competitive pressure*
11	Pilkington (2015)	Perceived benefits*, complexity*, technology maturity*, compatibility*, permissions (public v private blockchains) *	Organisational size*, top management support participation incentives*, innovativeness*, technological readiness*	Competitive pressure*
12	Morabito (2017)	Complexity, perceived benefits, compatibility*, maturity*, cost	Technological readiness, innovativeness*, value chain readiness*, top management support and involvement*, size	Regulatory environment*, government support, business use cases*, trading partner support*

14	Seebacher and Schüritz (2017)	Perceived benefits*, smart contract coding*, complexity	Technology responding capability, information intensity, organisational readiness*, value chain readiness*	Industry pressure*, business use cases*
15	Lindman et al., (2017)	Complexity*, perceived benefits*, technology maturity*, compatibility, technology architecture*	Technology readiness*, Value chain readiness, business models, organisational readiness*	Regulatory environment*, market dynamics*
16	Chen et al., (2018)	Perceived benefits*, complexity*, smart contract coding*, energy consumption	Top management support*, organisational readiness*	Market dynamics, governmental projects, Industry pressure*

*Considerations found to be significant.

Table 2. Summary of significant blockchain adoption considerations

Technological Considerations	Organisational Considerations		Environmental Considerations		
Perceived benefits	10	Organisational readiness ¹	12	Regulatory environment ²	11
Complexity	10	Top management support	8	Market dynamics ³	9
Compatibility	8	Organisational size	8	Industry pressure ⁴	5
Data security	6	Business model readiness	4	Government support	5
Maturity	5	Technology readiness	3	Business use cases	3
Relative advantage	4	Innovativeness	2	Trading partner support	3
Disintermediation	4	Participation incentives	1	Critical user mass	1
Smart contract coding	2	Blockchain Knowledge	1		
Architecture	1				
Permissions (public vs private)	1				

¹Includes value chain readiness; ² Includes government regulation; ³Includes competitive pressure

⁴Includes industry standards

As we can see in Table 2, specific TOE considerations stand out. From a technological perspective several considerations emerged as important: perceived benefits, complexity and compatibility. Perceived benefits refer to the study's/authors perception of the benefits (e.g., immutability, security, fast transactions etc.) that will accrue by adopting blockchain technology. Complexity refers to the intrinsic challenges (e.g. validation algorithms, smart contract frameworks, DLT skills, etc.) of developing blockchain technologies. Finally, compatibility refers to the ability of blockchain technologies to align with legacy systems (e.g., supply chain integration, system architectures, provider integration etc.). Next, three organisational considerations stand out: organisational readiness, top management support and organisational size. We provide a description of these three organisational considerations in relation to blockchain adoption in the next section. Finally, two environmental emerged as important considerations: the regulatory environment and market dynamics. In terms of the regulatory environment consideration, with the advent of any new technology (e.g., cloud computing and safe harbour data agreement) that disrupts an industry, governments will need

to review and resolve various related issues such as consumer protection, financial integrity and the lack of legislation which is specific to DLT. Market dynamics refers to the rapidly changing blockchain technological landscape which is forcing organisations to review their existing business processes to assess how they can use blockchain as a technology differentiator.

Discussion, Implications, Limitations and Conclusion

The research question at hand is, “What significant technological, organisational and environmental considerations influence blockchain adoption in organisations?” Our work reveals important technological, organisational and environmental blockchain adoption considerations which can be used as a foundation for advancing the blockchain adoption research agenda. As a background for our subsequent discussion, we focus on how the significant blockchain adoption considerations identified in Table 2 can be used to catalyse the blockchain adoption research agenda. As can be seen in Table 2, the top three significant organisational considerations are (1) organisational readiness, (2) top management support, and (3) organisational size. We will use the top three significant organisational considerations as mediating concepts to guide our discussion. Our reason for focusing on these three considerations is because organisational considerations are often viewed as the most significant determinants of IT innovation adoption in enterprises (Kimberly and Evanisko, 1981; Tornatsky and Fleischer, 1990; Damanpour, 1991). As a result, organisational considerations, such as top management support, firm size, prior IT experience, and innovativeness have been widely examined to ascertain the degree to which they constrain or act as a catalyst for the adoption of IT (Grandon and Pearson, 2004; Van de Weerd et al., 2016).

Top Management Support

Top management support has been identified as a key recurrent factor critical to the adoption of IT innovations (Sabherwal et al., 2006; Bajaj, 2008; Dong et al., 2009; Kulkarni et al., 2017). According to and Jarvenpaa and Ives (1990, p.205) “few nostrums have been prescribed so religiously and ignored as regularly as top management support in the development and implementation of IT”. We define top management support as “managerial beliefs about technological initiatives, participation in those initiatives, and the extent to which top management advocates technological advancement” (Kulkarni et al., 2017, p.7). High levels of top management support for a specific IT innovation ensures the long-term

vision, commitment and optimal management of resources, creation of a favourable organisational climate, support in overcoming barriers and resistance to change (Wang et al., 2010; Gangwar and Ramaswamy, 2015). In the context of blockchain adoption, top management support plays an important role because blockchain adoption may involve new regulatory requirements, a high degree of complexity, the acquisition of new resources, the integration of resources, the re-engineering of business-to-consumer and business-to-business transactions and information exchanges and the development of new skills and competencies (Swan, 2015; Plikington, 2016; Lansiti and Lakhani, 2017). A study conducted by Clohessy et al., (2018) confirmed that organisations that had adopted blockchain demonstrated high levels of management support. Furthermore, this study identified that within adopting organisations top management support for blockchain grew gradually and was influenced by employees who were able to demonstrate real world value of adopting blockchain in terms of creating blockchain prototypes which were underpinned by viable business models (Clohessy et al., 2018).

Organisational Readiness

Organisational readiness is conceptualised as the availability of specific organisational resources to adopt new IT innovations (Lacovou, Benbasat and Dexter, 1995; Weiner, 2009; Wang et al., 2010) This conceptualisation is frequently categorised under several headings, including human resources, financial, and infrastructure facets. Human resources facets refer to the presence of employees with the requisite knowledge, skill and experience to adopt new IT innovations (Wang et al., 2010). Next, financial facets refer to the allocated financial resources an organisation commits to new IT innovations (Weiner, 2009). While certain research has focused on the financial resources from the perspective of a specific IT innovation (e.g., Lacovou et al., 1995), in general, many studies have focused on financial resources from the perspective of any new IT innovation. Finally, infrastructure facets refer to existing IT platforms on which new IT innovations can be developed (Lacovou et al., 1995). When organisational readiness for a new IT innovation is high, an organisation's management and staff are more likely to initiate change, exhibit greater effort and persistence, and engage in enhanced cooperative behaviour (Weiner, 2009; Wang et al., 2010). Consequently, this results in a more effective adoption of the new IT innovation. The exact influence of organisational readiness on the adoption of blockchain is currently unclear. While existing theoretical research suggests that organisational readiness has a significant influence on the adoption of blockchain (Swan, 2015; Wang et al., 2016), there is currently a

dearth of empirical studies which have confirmed that this is the case. A study conducted by Clohessy et al. (2018) confirmed that the presence of sufficient organisational readiness in terms of the availability of financial and employee resources and access to IT infrastructure have a positive influence on a company's decision to adopt blockchain. This research conducted by Clohessy et al. (2018) also identified that the blockchain skills required by organisations for developing blockchain technologies could be categorised under the following technological competency headings: 1. foundational technology (e.g. cryptography, public key architecture); 2. distributed ledger technology (e.g. mining, consensus algorithms); 3. forensics and law enforcement (e.g. money laundering, darknet); 4. markets, economics and finance (e.g. game theory, business modelling); 5. industrial design (e.g. supply chain, IoT) and 6. regulations and standards (e.g. smart contracts and frameworks). Furthermore, the study confirmed that the availability and functionality of cloud-based blockchain development platforms were pivotal in triggering an organisation's decision to adopt blockchain.

Organisational Size

Organisational size is considered an important predictor of blockchain adoption (Tapscott, et al., 2016; Mendling et al., 2017). Extant research (e.g., Swan, 2015) and industry reports (Clohessy, et al., 2018) suggest that large organisations are more likely to adopt blockchain than small and medium enterprises (SME). Many past studies suggest that an enterprises' willingness to adopt a new innovative IT is positively influenced by organisational size (Damanpour, 1992). The reasoning behind this is that large organisations possess more complex and diverse facilities which positively contribute to adoption (Lee and Xia, 2006). Micro enterprises and SMEs, on the other hand, are susceptible to many barriers which constrain their ability to adopt IT innovations such as resource poverty (e.g. lack of IS personnel and expertise) and small IT budgets (Thong, 1995). However, our research indicates that in the case of specific IT innovations, because of the characteristics of the technology and the flexibility and adaptability of micro enterprises and SMEs, the opposite has been found. For example, empirical studies have shown that SMEs were more suitable and more inclined to adopt cloud computing technologies (Clohessy et al., 2017; Van de Weerd et al., 2016). Consequently, further empirical research is necessary to establish a consistent relationship between organisational size and blockchain adoption.

Implications

Practitioner and academic interest in the evolving phenomenon of blockchain is intense. Although this review cannot claim to be exhaustive, our study has outlined the benefits of blockchain technologies, provided an overview of potential business use cases and most significantly coalesced salient technological, organisational and environmental considerations which impact the adoption of blockchain technologies. Furthermore, we have provided an overview of how three of the main organisational considerations relate to the adoption of blockchain technologies. Our study can provide a useful quality reference source for practitioners and academics with an interest in blockchain and suggestions for future lines of research that will have strong implications for the practitioner community.

Limitations

It is worth highlighting some limitations and areas which may represent fruitful direction for additional research. First, we discussed three specific organisational considerations which influence a company's decision to adopt blockchain. As highlighted in Table 2, we also identified environmental, technological and other organisation considerations which also merit further investigation. We envisage that future research which investigates these categories of considerations might result in a more comprehensive analysis of blockchain adoption. Second, blockchain is a relatively young concept, and there are few well-established theoretical frameworks or unified discourses. While it is felt that the sample of publications is representative of the blockchain adoption literature, there may be some bias associated with the narrow focus of the research resources under review. Additionally, there are potentially research resources that investigate similar phenomena but discuss it with different terms, and thus, were difficult to find. We found throughout our survey of the literature that the only consistency pertaining to the concept of blockchain adoption is inconsistency. This fluid state of the blockchain field in conjunction with the subjective nature of the literature review filtering process – necessary due to the inconsistent use of the term across disciplines/fields – limits this work. However, at the same time, it seems that increasing the focus would not change the general conclusions or provide additional insights. Finally, we would also like to acknowledge the potential for researcher bias. Nevertheless, from the initial research design, through to the development of the methodology and the reporting of the findings, our research made use of an audit trail and audit process (Schwandt,

Lincoln and Guba, 2007). This ensured that our research was underpinned by rigour, authenticity and neutrality.

Conclusion

Using innovation theory (e.g., TOE framework), which has been extensively used to examine the adoption of IT in organisations, our research identified salient technological, organisational and environmental considerations which influence the adoption of blockchain by organisations. We also provided an overview of the blockchain concept and outlined the advantages and potential use cases that organisations contemplating adopting the technology can leverage. Every organisation is unique and has a different structure, culture, industry sectors, number of employees and so on. The combination of these factors affects an organisation's approach to blockchain adoption. We hope that our research endeavours in this article to coalesce the significant blockchain adoption considerations will ignite the spark for both researchers and organisations to investigate these considerations further. Having "stood on the shoulders of giants" by reviewing the extant research on blockchain adoption, like many scholars and IT analysts, we strongly believe that the blockchain concept has the potential to become the new frontier of competitive differentiation. Janus was the roman god of beginnings and endings. We believe that blockchain also encapsulates that duality. It will put an end to traditional ways of doing things and usher in a new era for business and for the world at large. It will be divisive, pervasive, and transformational all at the same time. It is time that organisations look ahead.

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