

Determinant factors of intention to adopt blockchain technology across academic libraries

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ABSTRACT

Academic libraries experience a lot of pressure due to rapid changes in technology, budget cuts and increasing demand of information services from their clientele. At the same time, libraries are expected to improve their information services at the global level to meet the increasing demands of libraries' population. Therefore, an effective collaboration in academic libraries is not an option anymore, but a necessity in order to cope with the rapidly changing technologies and external pressures. Blockchain technology because of its capabilities to record transactions and digital interactions in a transparent, secure, resilient, efficient and traceable way across untrusted parties, offers new opportunities for academic libraries' collaboration. However, due to its infancy stage of development, literature on blockchain technology adoption behavior is lacking, especially in the context of academic libraries. This therefore opens up the opportunities for further research in this area. Based on the technology innovation theory and technology-organisation-environment framework, a conceptual research model has been developed to investigate the determinant factors of intention to adopt blockchain technology in South African academic libraries' collaborative business processes. This conceptual paper also gives directions for future research in the form of 11 hypotheses.

CCS CONCEPTS

• **Computer systems organization** → Dependable and fault-tolerant systems and networks; • **Information systems** → Information storage systems; Storage architectures; Distributed storage; • **Security and privacy**;

KEYWORDS

Adoption, academic library, blockchain technology, collaborative business process, South Africa

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1 INTRODUCTION

In the current digital era, it is easier to access information from different sources than before. However, it is important to provide a reliable source of this information, and libraries successfully continue to achieve this task [10]. Academic institutions exist in a very complex and dynamic environment with challenges to which academic libraries have to respond in order to continue to be the 'hearts' of their universities, by connecting with the mission of the parent institutions [35]. Their focus is on providing quality information services to a very diverse group of students and faculty members with different information-seeking habits and needs [9], who normally do not voice out their dissatisfactions if they get poor service from their libraries [20].

Unlike profit making organisations, academic libraries do not rely on the benefit of quantitative measures such as profit and loss statements to identify the need for change, to motivate that need and to effect the change [20]. Rather, rapid change in information technology, changes in legislation, growing user demands, state of the global economy and currency fluctuations are the main drivers of how academic libraries should provide their services [2, 6, 20, 35]. As a result, academic libraries formed consortia to alleviate the common problems and pressures experienced, which are mostly too complex and large to handle on their own [6]. However, integration of their processes involves extensive information exchange which makes design and management of such processes difficult, and that results in data redundancy [13]. For these reasons, libraries still depend on the authorized third parties to automate their collaborative activities, and more costs are attracted for their coordination [1, 13].

Libraries have realized how digital innovations present novel capabilities and opportunities, which in turn require them to re-think of new ways of accommodating flexibility and freedom to adopt new technologies to solve nearly every existing problem in their field [9, 17]. Surprisingly, they have been slow adopters of these new technologies in their business processes [10], though scholars and practitioners maintained that academic libraries should radically change in order to stay relevant [20].

In order to achieve the mandate of the consortia formation of resource sharing at lower costs, collaborative technologies should be adopted to eliminate duplication of efforts, free up time for more important activities and improve service delivery [6, 9]. Blockchain technology because of its capabilities to record transactions and digital interactions in a transparent, secure, resilient, efficient and traceable way across the untrusted parties, offers new opportunities for academic libraries' collaboration without any central authority [10, 17], especially now when sharing has become a core value in the library world [6, 7].

However, due to its infancy stage of development, literature on blockchain technology adoption behavior is lacking, especially in the context of academic libraries, which opens up the research opportunities in this area [7]. It is therefore necessary to develop a comprehensive model for investigating the academic libraries' intention to adopt blockchain technology for their collaborative business processes in the context of South Africa because of well-established academic library consortia [6]. The model will be valuable to the practitioners in their strategic decision making when intending to adopt blockchain technology for their business processes, and to the researchers in the field for further knowledge development. Future research directions are also given in the form of hypotheses.

2 LITERATURE REVIEW

2.1 Blockchain technology overview

Blockchain technology application was first realised in a famous cryptocurrency, Bitcoin in 2009 which caught the attention of both practitioners and researchers [14]. Blockchain is defined as the distributed digital ledger of transactions immutably recorded in a chain of time-stamped blocks maintained by all participating nodes. The blocks are cryptographically linked and each block in the chain has the information about the previously added block, which makes it difficult to modify or delete after the approval by the participants [14]. The innovative power of blockchain stems from permitting untrusted parties to transact in a peer to peer network of computers enabled by consensus algorithms, cryptography and market mechanisms [25].

Blockchain offers another concept that is very crucial for business processes, called smart contract [25]. Smart contracts are user-defined 'self-executing scripts' on the blockchain network [30, 34]. The business processes are subjected to rules which have to be executed when certain conditions are met to automate inter-organisational business processes without central authority [25, 34].

2.2 Potential applications of blockchain technology in the information profession

Blockchain technology has captured the attention of many countries and industries, especially in finance and banking. The largest financial blockchain consortium, R3 CEV has launched its first blockchain-based system for banking and financial institutions [23]. The South African reserve bank released a report that shows positive results in blockchain trial for interbank electronic payments [4]. The Canadian government has implemented blockchain system that tracks cannabis production from 'seed-to-sale' to reduce regulatory costs, protect public safety and weaken illegal markets [23]. As a result, blockchain adoption may be catalyzed in use cases of other industries [4]. In this section, potential applications of blockchain technology in the information sector are discussed.

2.2.1 Provenance of digital content. With the use of blockchain technology, authorship contribution to a publication can be proved, which cannot be achieved by the current metrics used to evaluate author performance. Revisions of a paper by each author are logged at the user level, and at certain count of revisions made, they will be cryptographically recorded on blockchain until the paper

is finalized [26]. This can change people's perceptions about the intellectual property that concerns digital objects [7]. In addition to this, integrity of the document digitally stored on blockchain is preserved [26].

2.2.2 Bibliographic metadata. Because of the distributed nature of blockchain, libraries can use it for distributed metadata system whereby every library can access data without the central authority. This will eliminate costs which are currently incurred by using Online Computer Library Centre (OCLC) for metadata of items hosted by different organisations worldwide. The blockchain system will scale well while outputting quality metadata based on hashing [31]. All libraries in a consortium can handle interlibrary loans, patron authentication and collection management by using blockchain system, hence eliminating existing data silos with duplicates [7]. Moreover, Huwe [18] supports blockchain experimentation with metadata services application which may trigger large academic libraries and commercial partners, OCLC for example, to provide required expertise and resources to improve on metadata operations which will result in time-saving for librarians and information professionals.

2.2.3 Copyright management. There is currently lack of central storage for information about copyright owners of the copyrightable materials, this obscures transparency. It is timely and financially costly to get access to such digital content, which may lead to non-usage because of unclear legal status. These issues may be to a certain extent attributed to using expensive proprietary technologies which are not interoperable with each other, hence data sharing becomes difficult [32]. With blockchain technology, standardization and network effects in the copyright management can be achieved [32].

2.2.4 Digital first sale. For centuries, contracts have been deemed to be successful when parties do not disagree till the end. Otherwise disagreements come after the injury has occurred. Authors are not exceptions to this scenario [7, 33]. With the proposal of blockchain-based e-book platform from DECENT that allows self-publishing, digital first sale rights can be protected by implementing blockchain-based digital rights management (DRM) system using smart contracts and eliminate potential disputes between publishers and authors [7, 26]. Authors will have complete control in real time of how their digital assets can be accessed and used, and their pricing will no longer depend on the publishers. The aim of DECENT's proposal is to include reader-to-reader lending and direct author payments using cryptocurrency, which can benefit the libraries with low prices without publishers' inflated commission [7].

2.2.5 Credentialing. According to Huwe [18], the best way to decentralise services is to start by developing secure credentialing system that can be used for everyday personal needs. This will ensure proper use of resources as the unauthorised access will be well taken care of by the system through libraries as the top community service providers of blockchain services for cities, or even at the national level. Regardless of the of the library registered with, patrons can borrow, request items from any participating library in the network or from user who borrowed the item from the partner library [10]. However, the exercise will go beyond identity card

to gain access to services. A new vetting procedure which will incorporate extra coding expenses, will have to be employed [18].

2.2.6 Library network connection. Any kind of information can be shared on blockchain technology which include patron information that can be shared between the libraries when there is a need, with sensitive information being encrypted on the blockchain platform [33]. Libraries and universities can connect to form Inter-Planetary File System (IPFS) on blockchain ecosystem and eliminate internet service providers and large internet companies as gatekeepers [33].

2.3 Theoretical framework

Information Technology (IT) innovations are now part of every business because of their significant impact on organisations [12]. Intention to adopt a technology innovation to respond to dynamic customer needs and manage multiple partnerships depends mostly on the capabilities of new technology [5].

Blockchain technology is one the disruptive technologies with potential to revolutionise web-based information services in the information sector [16] and many other industries [17]. Since blockchain technology is still at its early stage of development, literature on its adoption behavior is limited, especially in developing countries such as South Africa [37].

While there is vast literature on new technology adoption [5, 12], much of it focuses on technology adoption theories at individual level instead of inter-organisational level [5]. Innovation Diffusion Theory (IDT) and TOE framework are mostly applied for adoption at organizational level, but they still borrow constructs from the individual technology adoption theories [5, 24]. In this study, the proposed model is aimed at inter-organisational level, where blockchain as a technology is expected to have significant impact by facilitating data sharing between institutions, not for individuals to interact with online. Therefore, individual technology adoption theories will not be suitable to investigate its adoption [17].

2.3.1 Innovation Diffusion Theory (IDT). IDT helps to explain how and why members of the social system adopt an innovation over time [11]. IDT has mostly been used by researchers both at individual and institutional technology adoption levels [21], and its attributes (relative advantage, complexity, compatibility, trialability and observability) identified by Rogers in 1983, account for a significant variance in innovations adoption at organizational level [5].

2.3.2 Technology-Organisation-Environment (TOE) framework. TOE framework identifies three perspectives that influence the process by which organisations adopt new innovations [28]. This framework has been empirically used to determine factors that influence technological innovations adoption at the organisational level in the contexts of technology, organisation and environment to overpower IDT [3, 24, 28]. These considerations can provide barriers and benefits to innovation adoption. In the context of this study, the technological context consists of relative advantage, complexity, compatibility and cost which can impact on the already adopted systems and the 'to be' adopted technology [24, 29]. The organizational context consists of organizational size, management support and IT readiness [5, 24]. Lastly the environmental context

consists of industry support and customer pressure which affect the daily operations [12].

3 CONCEPTUAL FRAMEWORK

The proposed research framework in this study, 1, is based on the TOE framework which looks at inter-organisational innovation adoption at organisational level from multiple perspectives, of which DOI cannot fulfil [24]. In addition to three perspectives covered by TOE, inter-organisational relationship has been introduced as the fourth perspective to consider in blockchain adoption between different institutions, but it has been ignored in the previous literature [5]. Using the model proposed in 1, hypotheses have been derived to be used as the guide to study the intention to adopt blockchain technology across academic libraries in South Africa.

3.1 Technological context

Technological context refers to the internal and external technologies that are relevant to the organisation, including those which have not yet been used by the organisation. The adoption decision of these technologies is influenced by the perceived benefits which may be realised through the use of the technological innovation [24]. However, the need to maintain success with daily operations using the existing technological systems while adapting to new technological innovation is a challenge for many organisations [17]. The proposed conceptual model identifies four constructs (relative advantage, complexity, compatibility and cost) which are predominantly used in the new innovation adoption [5] to determine the intention to adopt blockchain technology in the context of South African academic libraries.

3.1.1 Relative advantage. Relative advantage refers to the extent to which technological innovation is perceived to be better than the one it replaces [5, 27, 36]. Maduku et al. [24] emphasise that decision makers tend to adopt technology if they anticipate the benefits over the existing one outweigh the risk of adoption. Researchers in most of the adoption literature have identified positive relationship between relative advantage and intention to adopt technology [5, 24]. Therefore, it is hypothesised that:

H1: The relative advantage of the innovation positively influences the intention to adopt blockchain technology.

3.1.2 Complexity. Complexity refers to the extent to which technological innovation is found to be difficult to understand and use [36]. The extent to which organizational employees perceive the use of new technology to be easy, is found to positively influence the intention to adopt such technology [24]. However, if the technology is perceived to be difficult to understand, implement and use, it is associated with high level of uncertainty towards successful adoption of new technology. Complexity of the technology has been found to have negative impact on the intention to adopt the innovation [5]. It is therefore hypothesised that:

H2: The complexity of the technology negatively affects the intention to adopt blockchain technology.

3.1.3 Compatibility. Compatibility refers to the extent to which technology is perceived to be consistent with organisational values (internal culture, business processes, management practices) [5], and compatible with the existing technology settings [15]. For any

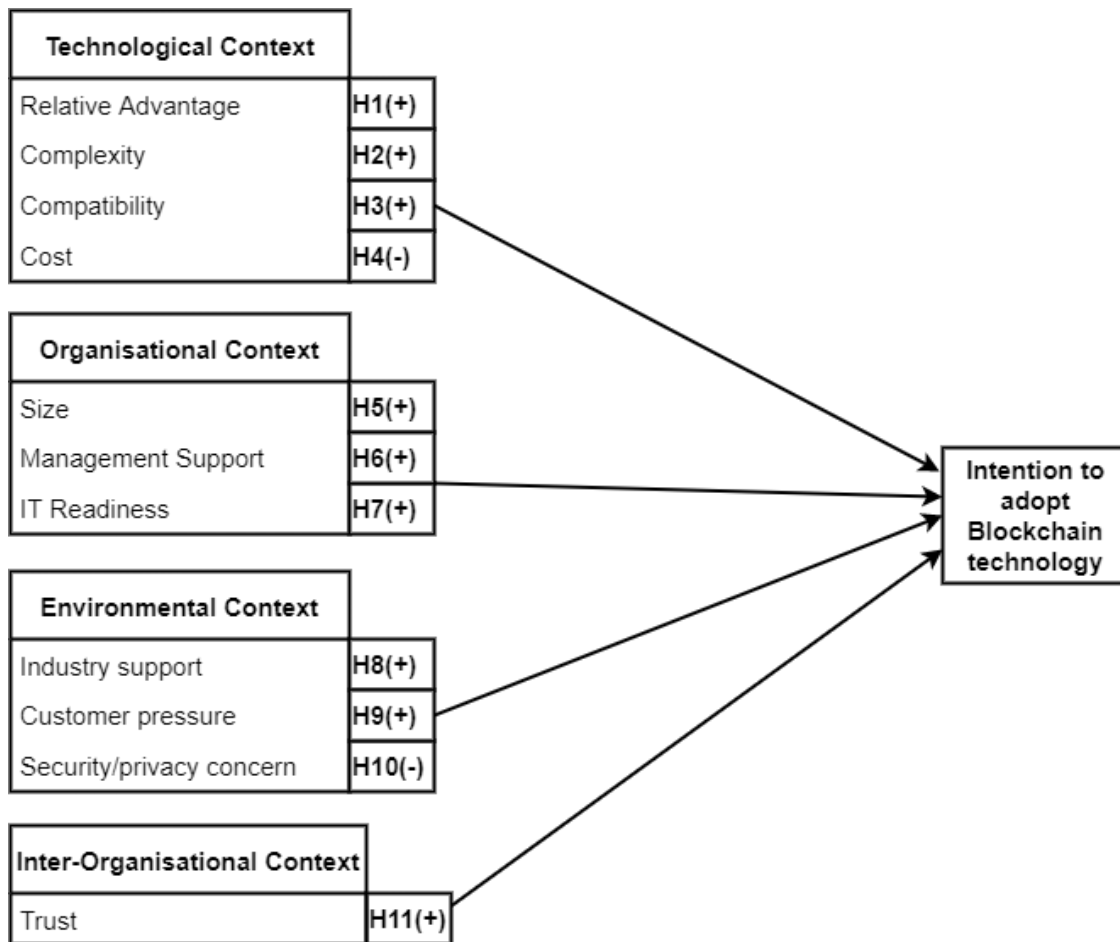


Figure 1: Conceptual model adapted from Asare, Brashear-Alejandro and Kang [5].

proposed technological innovation to be considered for adoption, it has to be compatible with the existing technology setting and must fit the task it is intended for [19]. It is hypothesised that:

H3: The technology compatibility positively influences the intention to adopt blockchain technology.

3.1.4 Cost of innovation. Cost of innovation may be direct and indirect. Direct cost refers to the actual price to be paid for acquisition of new technology, and indirect costs are the costs incurred when implementing, using, and maintaining the technology. High cost is a barrier to any product acquisition and negatively affects the adoption [5]. Batubara, Ubacht and Janssen [8] suggest that benefits of the blockchain technology should be higher than the cost of its development and maintenance. Therefore, it is hypothesised that:

H4: The cost negatively influences the intention to adopt blockchain technology.

3.2 Organisational context

Organisational context refers to the characteristics and the resources an organisation has which may be constraining or facilitating factors for the innovation adoption intention [3]. In order

to stay competitive in the market, organisations have to emphasise on digital innovation adoption, which according to previous research, leads to new tasks and coordination methods. In essence, integrating more technologies to business processes shape the organisational behaviour because they deviate from their existing, proven traditional innovations to develop new routines, beliefs and procedures, hence new identities [17]. In this study, organisational context is characterised by three constructs which include organisational size, management and IT readiness because they are frequently found to influence the adoption of technological innovations [3].

3.2.1 Organisational size. Large organisations are believed to have high likelihood of adopting new technologies because of higher capacity than small organisations [22]. However, Asare, Brashear-Alejandro and Kang [5] argue that organisational size has been both negatively and positively associated with intention to adopt new technology, but positive influence is dominating in the literature. Blockchain technology requires technical expertise, which is more likely to be housed in large organisations than in small organisations. For this reason, organisational size has positive influence in adopting new innovation [22]. Therefore, it is hypothesised that:

H5: The size of the organisation positively influences the intention to adopt blockchain technology.

3.2.2 Management support. Management support refers to the level of commitment and support offered by top managers towards the new technology adoption requirements [15]. This support is important especially for inter-organisational technologies because they are expensive and complex, and they require long-term vision among the partners [5]. There is a need for recognition, support and buy-in from the management of the university for collaborative activities to be successful [6]. It is therefore hypothesised that:

H6: The management support of the innovation positively influences the intention to adopt blockchain technology.

3.2.3 IT readiness. The technology readiness of the organisation refers to the level of IT management complexity in an organisation [5] and likelihood of people with different skillsets to embrace and use new technologies to achieve their business goals [6, 21]. Lai [21] further notes IT readiness as very important because it determines the implementation success. Organisations with complex IT infrastructure are more likely to have the required expertise and resources to adopt new technologies than those organisations with less complex IT infrastructure [5]. Employees with the understanding of the resources available to support blockchain in this case influence the intention to adopt. Atkinson [6] notes that carrying out activities at an early stage that help participants understand their roles and issues around the technology adoption is very important. In previous literature, IT readiness has been identified to positively influence the adoption and use of the new technology [5]. It is therefore hypothesised that:

H7: IT readiness positively influences the intention to adopt blockchain technology.

3.3 Environmental context

Environmental context refers to the influences from the domain in which organization conducts its business. These factors are external to the organisation but have impact on organisational performance and have been constantly found to affect technology adoption at the organisational level [5]. According to the proposed research model, industry support and customer pressure have been identified as the constructs that affect blockchain technology adoption intention especially in developing countries like South Africa [24].

3.3.1 Industry support. Industry support refers to support from the associations in the sector, availability of established industry standards which are aimed at promoting and managing new technologies. Associations normally organise workshops to train staff and provide technology infrastructure for members. Through these initiatives, organisations feel empowered to adopt new technology [5, 24]. Therefore, it is hypothesised that:

H8: The industry support of the new technology positively affects the intention to adopt blockchain technology.

3.3.2 Customer pressure. Customer pressure refers to persuasion and encouragement coming from the customers to adopt a certain innovation to meet their high expectations, otherwise organisations lose relevance to the customer [17], [24]. It has been found that

innovation adoption is driven by meeting customer needs electronically for better communications [24]. In the study context, libraries will be forced to adopt blockchain technology because they believe it will help them meet their customers' needs. Therefore, it is hypothesised that:

H9: The customer pressure positively affects the intention to adopt blockchain technology.

3.3.3 Security and privacy regulatory concern. Security and privacy regulatory concern refers to the uncertainty of compliance to the regulations of data security and privacy in adopting new technology [39]. In academic libraries, data collections about individuals are involved, and they are achieved through direct interaction with patrons and other business collaborations [38]. With blockchain by design, data confidentiality may not be achieved [29]. Thus, when sensitive data have to be shared across different institutions, issues of data privacy and confidentiality will arise. As a result, organisations may be reluctant to adopt blockchain technology in the absence of the comprehensive regulatory framework [38], regardless of the long history South African academic libraries have in collaboration through consortia formation [6]. It is therefore hypothesised that:

H10: Security and privacy regulatory concern negatively affects the intention to adopt blockchain technology.

3.4 Inter-organisational relationship

The relationship between collaborating partners is very important as it will be easy for partners to subscribe to a certain collaborative technology to streamline their operations, especially when they involve information sharing. Trust appears to be the dominant factor in the context of the academic libraries' relationships [29].

3.4.1 Trust. Trust refers to the willingness of two or more institutions in partnership to rely on one another to benefit from their partnership [29]. Trust is established when one party believes that another partner has honesty, skill and knowledge related to a particular task which is motivated by the joint gains [5]. Trust is very important in inter-organisational technologies because collaboration involves sharing and access of confidential information [5, 29]. Trust in collaborative relationship reduces perceived risk between partners. So, without trust and openness, partners are reluctant to adopt shared technologies to realise considerable benefits for their libraries [6]. It is therefore hypothesized that:

H11: The level of trust between collaborating partners positively influences the intention to adopt blockchain technology.

4 CONCLUSION

Blockchain is a nascent technology which presents potential applications and benefits in different areas. However, there is limited research in blockchain adoption for library and information sector in general. This creates an investigation opportunity for researchers to explore the technology application in this area, especially in developing countries like South Africa. Lack of empirical evidence in the existing literature justifies the gap that needs to be filled. The model which encompasses inter-organisational relationship has been proposed to consider a holistic view of factors that need to be

addressed in order to expedite cooperative adoption of blockchain in the library and information profession.

It is confirmed that technological determinant factors are dominant in the adoption of blockchain technology in this review. As a result, proper evaluation should be done for appropriateness of blockchain technology to solve social problems, with consideration of technology properties and processes it is applied to. It is therefore necessary for information professional and the public to know about blockchain and how it can affect their business processes. However, it is evident that globally there is progress in blockchain technology development in terms of research and adoption in many industries, but the intention to adopt blockchain by academic libraries to automate their collaborative activities in South Africa is not known.

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