Analysis of factors influencing blockchain implementation in finance sector in Sri Lanka

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ARTICLE INFO

DOI:10.46223/HCMCOUJS.econ.en.12.2.2236.2022

Received: April 09th, 2022

Revised: May 23th, 2022

Accepted: June 02nd, 2022

Keywords:

blockchain technology; business transformation; distributed ledger technology; finance sector

ABSTRACT

The global finance industry is highly impacted by fintech innovations and technology transformations due to rapidly evolving emerging technologies. Blockchain has become one of the key emerging technologies to bring promising results in the finance sector. These transformations and the use of decentralized ledger systems would contribute to significant changes in financial transaction processing and with the advent of distributed ledger technology and its ability to enforce better transparency, blockchain is becoming a disruptive force in the finance industry. This research investigated challenges in implementing blockchain solutions in the finance sector in Sri Lanka. The Interpretive Structural Modeling (ISM) based approach was used to investigate relationships between identified factors that influence blockchain solutions. According to the results of the study, the factors with higher driving power included lack of trust in new and immature technology, lack of regulations and governance, lack of standardization, cost of implementation, and interoperability issues with legacy systems. The results of the study emphasize the importance of regulatory bodies to develop new rules and regulations to support the technology transformation and blockchain vendors to provide better interoperability and standardization across platforms.

1. Introduction

Blockchain which is a secure and decentralized open ledger that is proposed to store transactions without a third-party authentication permanently has received significant attention from financial technology experts and researchers. With the usage of blockchain, it is not necessary to rely on one single organization's involvement in maintaining authoritative records, but other parties who are authorized and interested could maintain a replicated copy of the ledger. Through cryptographic services of blockchain, it ensures that any kind of tampering with replicated copies of these ledgers is not possible. Based on the governing rules of blocks in the blockchain: how to add and remove blocks, blockchains are classified as permissioned and permissionless. Permissionless blockchain does not provide any privileges or special rights to its anonymous users and is commonly used in cryptocurrencies. Permissioned blockchains are most suitable for finance sector applications that are used to provide regulated services to their customers. In a permissioned blockchain, only verified participants based on their preauthorized privileges would be allowed to add or edit a transaction in the chain.

However, since blockchain technology is a major breakthrough and a technological disruptor, some organizations have already initiated the implementation of blockchain technology into their business process although it is still challenging for an organization to adopt new technology without having a sufficient readiness for digital transformation (Cunningham, Routi, Yerukhimovich, & Clark, 2020). In general, most the financial services in the world solely follow a centralized approach to their data operations where the data are transmitted through multiple intermediaries but with a minimal transparency. Furthermore, these centralized databases kept under a maximum level of protection are often vulnerable to data breaches. Due to a lack of transparency, if a data breach happens, the situation will be complicated since the discrepancies in transactions are not revealed until the identification of a breach. Therefore, due to its distinct features such as decentralized ledger, immutability to changes in blocks, and higher security through encryption, blockchain has become a favorable technology to transform the finance industry.

In response to the increasing demand for the digital transformation of the financial sector in Sri Lanka, the Central Bank of Sri Lanka which is the monetary authority of Sri Lanka requested finance sector institutions to evaluate the possibility of adopting blockchain technology to streamline Know-Your-Customer (KYC) processes. But only a few financial institutions responded and explored potential use cases using a KYC system to share and update customer information using blockchain technology since the realization of benefits of blockchain technology applications is not clear. Therefore, an in-depth study on how a decentralized blockchain solution influences the centralized financial system in Sri Lanka is important.

In this research, we conducted a comprehensive study on challenges in implementing blockchain technology solutions and strategic and technical implications during adopting technology transformation in the finance industry in Sri Lanka. The findings of this research would help banking institutions to be aware of distributed ledger technology, explore blockchain technology as a feasible solution and embrace this technology while overcoming any challenges. This research further explored the challenges faced by a few finance sector organizations outside Sri Lanka and selected local finance companies in Sri Lanka which have initiated implementation of blockchain solutions. Based on a comprehensive and in-depth analysis, the research identified factors that influenced the implementation of blockchain solutions in the finance sector and the final results would assist financial institutions to formulate necessary policies for technology transformation.

2. Literature review

2.1. Financial sector in Sri Lanka

The financial service sector of any country is considered the primary driving force behind the economy and comprises banking and non-banking institutions, asset management institutions, insurance companies, and other organizations that offer different financial services. Primarily, some of the main services include personal finance services, consumer finance services, and corporate finance services (Phaneuf, 2020). In the Sri Lankan context, "financial institutions, namely the Central Bank of Sri Lanka (CBSL), Licensed Commercial Banks (LCBs), Licensed Specialized Banks (LSBs), Licensed Finance Companies (LFCs), Specialized Leasing Companies (SLCs), Primary Dealers (PDs), Pension and Provident Funds, Insurance Companies, Rural Banks, Stock Brokers, Securities Market Intermediaries, Unit Trusts and Thrift and Credit Co-operative Societies" comprise the financial system in Sri Lanka (Central Bank of Sri Lanka, 2020). The recent advancement of technologies has started revolutionizing the global financial sector through the creation of new business propositions which include mobile banking, online payment gateways, peer-to-peer lending, crowdfunding, digital and crypto currencies, and digital wallets (Frew, 2021). Emerging technologies such as artificial intelligence, machine learning, and

blockchain have become disruptors in financial sectors and are facilitating to build of smarter and more effective financial systems. Blockchain facilitates use of smart contracts which reduces the reliance on intermediate stakeholders and eliminate transactions delays while increasing transparency and traceability of financial transactions (Turpitka, 2020). Therefore, it is evident that these emerging technologies have enormous capabilities to provide enhanced data security, faster financial transactions, and better customer service while reducing financial crimes (Turpitka, 2020). After recognizing the true potential of blockchain technology, more financial companies are turning to the digitization of financial instruments which redefines the financial processes in the sector. With major benefits such as higher data integrity, asset provenance capabilities, overall operational efficiency, greater customization of digital securities, and reduced operational and transaction costs, decentralized blockchain will provide a transformative advantage over current centralized technologies. Therefore, blockchain technologies have received greater attention from major financial and fintech companies which have started investing heavily in the digitization process. With this opportunity to modernize the finance sector and offer more efficient and secure financial products and services to their customers, a greater competition can be observed for financial and non-financial institutions to incorporate blockchain technologies (Seibold & Samman, 2016).

In Sri Lanka, institutions have begun to investigate blockchain technology. The Central Bank of Sri Lanka has also taken some initiatives to popularize blockchain implementation in the finance sector. A very few local financial institutions have embraced blockchain technologies and have started developing new solutions for their clients (Moody's Analytics, 2019). The Central Bank of Sri Lanka (CBSL) has already initiated establishing shared KYC services using Blockchain technology. Despite some great potential to provide secure financial transactions through increased visibility and transparency of transactions, the use of blockchain in Sri Lanka for financial fraud reduction is yet to be investigated (Goonathilaake, Deshapriya, Jayakody, & Dharanidu, 2018). Despite those promising factors, there are many challenges that local financial and non-financial institutions have to experience in adopting blockchain technology. In this research, we analyzed challenges faced by the finance sector in implementing blockchain solutions and developed a framework to support them in implementing blockchain solutions in their organizations.

2.2. Blockchain technology

Unlike in a traditional centralized banking ledger system where a bank has full control of transactions posted into the ledger, in a decentralized and distributed ledger such as blockchain, there is no central authority and the ledger database is distributed on all nodes of the network enabling each node to keep an identical copy of the ledger (Kuijpers, 2018). The integrity of transactions is ensured through Public Key Infrastructure (PKI) which uses asymmetric encryption techniques utilizing a public key and a private key to encrypt and decrypt to authenticate the content of a transaction in a ledger (Seibold & Samman, 2016). Blockchain utilizes a consensus mechanism to establish an agreement on a transaction on a distributed and authenticate or validate a value or a transaction, allowing the blockchain network to come to a common consensus on a new transaction state of the distributed ledger. Therefore, consensus protocols play a vital role in blockchain networks by facilitating consistency and agreement between two nodes in the network. There are several consensus algorithms commonly used in blockchain networks. Proof of Work (PoW) and Prof of Stake (PoS) are commonly used consensus algorithms. PoW requires the participant node to prove that it qualifies and receives the right to add a new transaction to the blockchain whereas PoS requires nodes to stake a new transaction data to get a chance of being selected to perform a block transaction. These nodes are an indispensable part of a blockchain

network and are used to store blocks of data in the blockchain. Therefore, any kind of devices such as computers, laptops, and servers may be considered as node and further a node may also be a virtual machine for its functionality (Seibold & Samman, 2016). In order to enhance audibility, permissioned identities through encrypted transactions can be integrated into the blockchain and these encrypted transactions create an audit trail in the blockchain (Seibold & Samman, 2016). Therefore, blockchain protocols enablefinancial institutions to transform the whole business process in a more efficient, secure, and economical manner while eliminating operational risks.

2.3. Blockchain technology and institution's business model

The strategic business model of an institution that architects how the institution creates, distributes, and acquires values considering the financial, intellectual, and physical assets of the institution (Frankenberger, Mueller, Spangler, & Alexander, 2014; Halas, 2019; Weking et al., 2020). Blockchain technology, due to its nature will transform the current business process of many institutions to distributed, peer-to-peer structure creating new values in governance and possibilities for new business models (Subramanian, 2018) while it introduces new constraints on business models. Despite the potential challenges in the early adoption of emerging technology, blockchain technologies bring many potential benefits for institutions to invest in blockchains such as cost savings, faster transaction processing, sharing risks, efficient record keeping due to distributed ledgers, efficient business process and improved data traceability and verification (Ying, Jia, & Du, 2018). Blockchain also provides multi-factor, decentralized authentication, and authorization system to secure digital assets from cyber-attacks and hacking (Nowiński & Kozma, 2017). Moreover, blockchains' operation supports automated, simplified, and efficient processes while maintaining security through a complex validation processes.

2.4. Factors influencing blockchain implementation

Many financial organizations are attempting to use distributed consensus processes, but regulations and costs are major obstacles. Therefore, institutions are required to assess a few critical aspects before making a large investment such as scope, counterparties, process, data, technology, people, regulatory, industry, business case, and performance security (Seibold & Samman, 2016). Contracts in the finance sector enforce economical, legal, and political requirements in a country when a transaction happens involving two or more parties (Lansiti & Lakhani, 2017). Therefore, a smart contract would be a critical component of a blockchain and some major changes in contract law has to happen which can interpret and enforce smart contracts if a distributed ledger application in blockchain to be adopted in the finance sector. Some of the challenges would include negotiating, drafting, and adjudicating smart contracts written by a third party, finding the final contract agreements if multiple amendments are available, and finding governing laws and jurisdictions. However, while blockchain will have a huge influence, full adoption may need more time to pervade economic, legal, and social infrastructure.

Blockchain also faces the number of technological and implementation challenges due to the non-standardized array of technologies by multiple vendors and requires addressing issues related to cross-industry usage and use cases. Therefore, interoperability between blockchains with different protocols, privacy and security implementations, and user consensus mechanisms should be provided to facilitate industry-wise uniformity in blockchain standards and protocols. These standards will help institutions to collaborate, share and validate blockchain solutions. Further, the difficulty in blockchain integration with the existing legacy systems without complete restructuring and data loss has negatively influenced institutions to transition to a distributed ledger system. Despite the secure consensus mechanisms that blockchain employs, like any other technology, this technology is also subject to cybersecurity breaches which require proactive

surety risk management, especially maintaining the confidentiality and integrity from identity-based attacks. In addition to technological hurdles in implementing blockchain solutions, financial institutions are concerned with the lack of legal and regular framework for blockchain based financial transactions. Furthermore, the environmental impact of adding additional blocks to a blockchain is also to be noted since it may consume a large amount of power due to its computational complexity when a new block is created in the blockchain or a new transaction is validated (The Economist, 2015).

The influence of members in the technology ecosystem has a substantial role in contributing to environmentally sustainable growth. To capitalize on the value proposition, the blockchain ecosystem should be supported by developers, entrepreneurs, managers, investors, and, most importantly, early adopters who can provide the technical leadership (Kabashkin, 2017). Blockchain technology implementations can be already seen in some commercial applications such as supply chain and logistics management (Mougayar, 2016). It is now evident that distributed ledger technology is expanding within the financial sector and new financial business models based on blockchains are established (Seibold & Samman, 2016), with changes to existing legacy processes. But the scarcity of blockchain implementation skills and adequately trained and experienced professionals to design, develop and manage them has become a bottleneck for implementors of blockchain solutions (Korpela, Hallikas, & Dahlberg, 2017). Having a sufficient skilled and experienced talent pool to meet the demand would be challenging.

The adoption of newer technology or transformation of technology may be challenging when structural changes are required within the institution. Furthermore, lack of awareness about the emerging technologies and lack of readiness in adopting new technologies are major obstacles for an institution to migrate to new technology (Poszler, Ritter, & Welpe, 2019). The success of implementing blockchain technology as a cross-organization solution is determined by the parties conduct and connections (Seebacher & Schüritz, 2017) and the most values of technology migrations can be harnessed when an organization works on a shared opportunity.

Another important deciding factor in implementing a distributed ledger technology within an institution is the cost of blockchain implementation. For the adaptation of blockchain technologies into an institution, a considerable amount of initial investment associated with their deployment is required (Block & Marcussen, 2019) although the post-implementation stage of blockchain brings efficient and effective transaction processing (Korpela et al., 2017). Institutions are concerned about the cost of acquiring, transforming, and implementing new technologies at the beginning (Heillig, Schwarze, & Voss, 2017). Although the cost of creating awareness of newer technologies and educating and building staff confidence to deal with these changes are significant. institutions must be prepared to make those investments at the beginning if a new technology is to be integrated into the organization.

Based on the literature review, major challenges were identified for blockchain implementation in the Finance sector and were explained and cited in the literature review. Identified factors were reviewed through an expert panel discussion and subsequently, thirteen factors were selected to evaluate the challenges in implementing blockchain technology in the finance sector in Sri Lanka as depicted in Table 1.

3. Methodology

3.1. Data collection

Table 1

Challenges in implementing blockchain technology in the finance sector

Code	Factors	Description
C1	Lack of trust in new and immature Technology	Availability of few success stories of full implementation of distributed ledger technology of blockchain in the finance sector.
C2	Lack of standardization	Connecting multiple on-premise databases, cloud-based databases with multiple blockchain technologies by different vendors.
C3	Legal issues	Legal issues and complexities related to creating, executing, revising, accepting, and maintaining smart contracts and agreements in blockchains.
C4	Inadequate training opportunities	Tools, resources, skills, and infrastructure requirements for training ofemployeese in blockchain technology.
C5	Lack of regulations and governance	Undefined or unclear rules and regulations related to transactions on blockchains.
C6	Lack of management initiatives and commitment	Lack of awareness and understanding of the benefits of blockchain technology by decision-makers.
C7	Lack of expertise and skills	The shortage of adequately qualified, skilled, and experienced professionals for the development of blockchain technology.
C8	Cost of implementation	Initial and latency investments are involved in technology transformation.
C9	Concerns related to the scalability	Technical capabilities of blockchain to handle processing a large volume of concurrent transactions.
C10	Security concerns	Security breaches in applications, security vulnerability of data, and privacy protocols in blockchains in finance sector applications.
C11	Interoperability issues with legacy systems	Integrating existing legacy systems to the blockchain without losing data and the amount of reengineering required to implement blockchain.
C12	Lack of motivation of internal staff	Employee buy-in of technology transformation and willingness in engage in the process.
C13	Adaptation of blockchain technology in the finance Sector	Acceptance of technology transformation using distributed ledger technology.

Source: The researcher's data analysis

The blockchain technology is considered comparatively new to the financial sector and there are only few early adopters. Therefore, the inductive research method which has been widely used in qualitative research when information about certain phenomenon was gathered from observations which are relavant to the topic of interest through interviews, was adopted in this research. This information was analyzed using thematic analysis method and analyzed data was then fitted into a proposed model (Bryman & Bell, 2015).

3.2. Interpretive Structural Modelling (ISM) approach

Table 2

SSIM for factors influencing implementation of blockchain Technology in Finance Sector

	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**	**C12**	**C13**
C1		A	A	X	X	V	X	V	V	V	A	V	V
C2			O	O	X	V	O	V	V	A	X	O	V
C3				O	X	V	O	X	O	O	X	O	V
C4					O	A	X	X	O	O	O	V	V
C5						V	O	O	X	X	X	O	V
C6							A	A	A	A	A	V	V
C7								V	O	O	O	V	V
C8									A	A	A	O	V
C9										O	A	O	V
C10											O	O	V
C11												A	V
C12													V
C13													

Source: The researcher's data analysis

In this paper, we used Interpretive Structural Modelling (ISM) (Sage, 1977) to investigate the relationship between factors that have been identified as challenging for the implementation of blockchain technologies in the finance sector. Since multiple factors would have a complex relationship to the blockchain technology implementation, ISM would be able to establish some contextual relationship between factors identified in the study by reachable matrix and ISM based model.

Table 2 depicts the values of the Structural Self-Interaction Matrix (SSIM) which reflects the pair-wise relationship of the factors that were selected for the study. The following coding was used in developing SSIM: V if the factor C_i influence the factor C_j, A if the factor C_j influences the factor C_i, X if the factor C_j and the factor C_i complement each other and O if the factor C_j and the factor C_i unrelated.

Initial Reachability Matrix was then developed from SSIM using the following coding for $a_{i,j}$ where $a_{i,j}$ is the (i,j) element of the matrix: $a_{i,j} = 1$ for (i,j) element and $a_{i,j} = 0$ for (j,i) element if $a_{i,j} = V$, $a_{i,j} = 0$ for (i,j) element and $a_{i,j} = 1$ for (j,i) element if $a_{i,j} = A$, $a_{i,j} = a_{j,i} = 1$ for (i,j) element and (j,i) element if $a_{i,j} = X$, and $a_{i,j} = a_{j,i} = o$ for (i,j) element and (j,i) element if $a_{i,j} = O$.

Table 3

Initial reachability matrix for factors influencing implementation of blockchain technology in the finance sector

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	Driving Power
C1	1	0	0	1	1	1	1	1	1	1	0	1	1	10
C2	1	1	0	0	1	1	0	1	1	0	1	0	1	8
C3	1	0	1	0	1	1	0	1	0	0	1	0	1	7
C4	1	0	0	1	0	0	1	1	0	0	0	1	1	6
C5	1	1	1	0	1	1	0	0	1	1	1	0	1	9
C6	0	0	0	1	0	1	0	0	0	0	0	1	1	4
C7	1	0	0	1	0	1	1	1	0	0	0	1	1	7
C8	0	0	1	1	0	1	0	1	1	1	1	0	1	8
C9	0	0	0	0	1	1	0	0	1	0	0	0	1	4
C10	0	1	0	0	1	1	0	0	0	1	0	0	1	5
C11	1	1	1	0	1	1	0	0	1	0	1	0	1	8
C12	0	0	0	0	0	0	0	0	0	0	1	1	1	3
C13	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Source: The researcher's data analysis

In order to construct the hierarchy graph, reachability set, antecedent sets, and intersection set were generated for each influencing factor based on the reachability matrix. The reachability set of each identified factor included the factor itself and the other factors which support it and the antecedent set of each factor represents the factor itself and the other factors that influence it. After completing the reachability set and antecedent set, the intersection set was found to identify common factors for both the reachability set and antecedent set. The level hierarchy of factors were then found based on the reachability set and intersection set as depicted in Table 4.

Table 4

Partition of reachability matrix and levels

	Reachability Set	Antecedent Set	Intersection Set
C1	1,4,5,6,7,8,9,10,12,13	1,2,3,4,5,7,11	1,4,5,7
C2	1,2,5,6,8,9,11,13	2,5,10,11	2,5,11
C3	1,3,5,6,8,11,13	3,5,8,11	3,5,8,11
C4	1,4,7,8,12,13	1,4,6,7,8	1,4,7,8
C5	1,2,3,5,6,9,10,11,13	1,2,3,5,9,10,11	1,2,3,5,9,10,11
C6	4,6,12,13	1,2,3,5,6,7,8,9,10,11	6
C7	1,4,6,7,8,12,13	1,4,7	1,4,7

	Reachability Set	Antecedent Set	Intersection Set
C8	3,4,6,8,9,10,11,13	1,2,3,4,7,8	3,4,8
C9	5,6,9,13	1,2,5,8,9,11	5,9
C10	2,5,6,10,13	1,5,8,10	5,10
C11	1,2,3,5,6,9,11,13	2,3,5,8,10	2,3,5
C12	11,12,13	1,4,6,7,12	12
C13	13	1,2,3,4,5,6,7,8,9,10,11,12,13	13

Source: The researcher's data analysis

Based on the reachability matrix, a hierarchical representation of factors as a digraph was developed which depicts the factors at different levels and relationships between factors. The ISM model as depicted in Figure 1 shows all factors and their relationships using arrows.

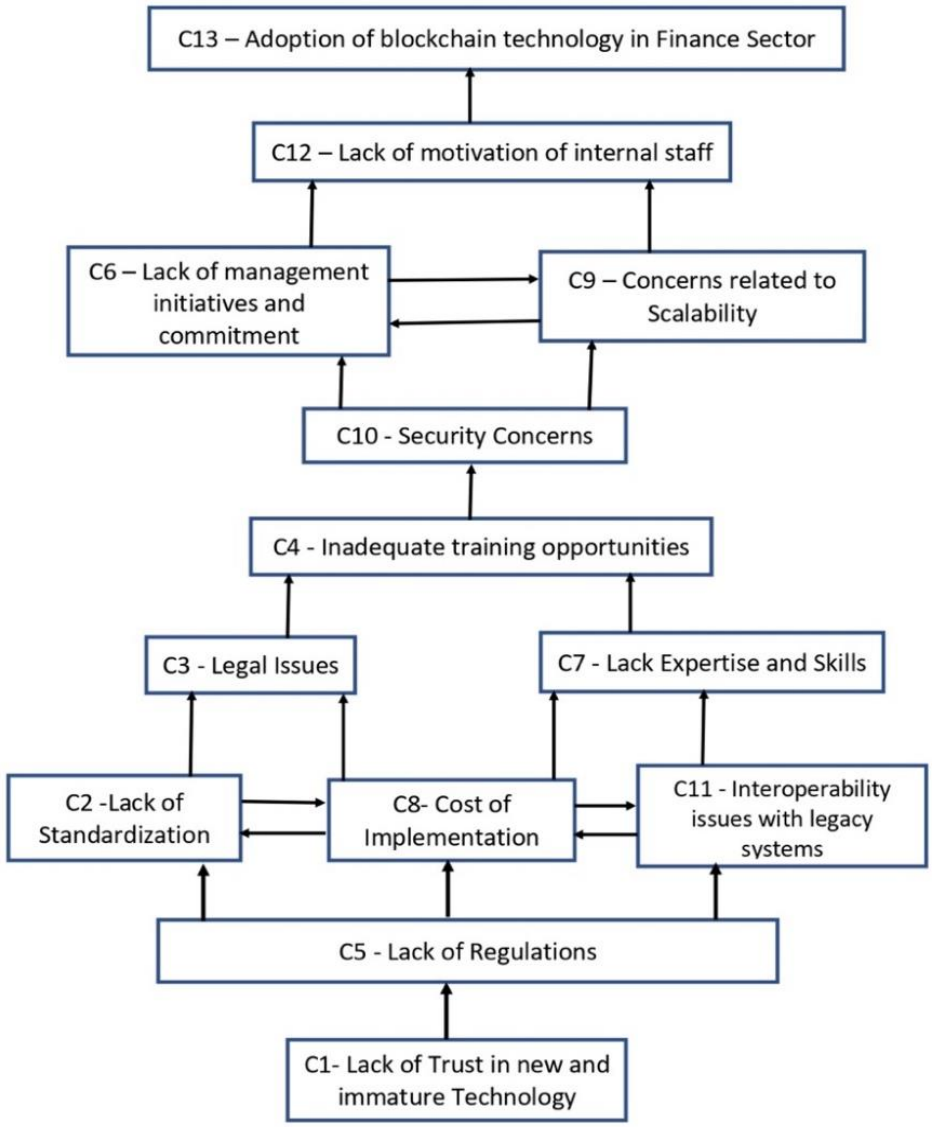

Figure 1. ISM based model for challenges in implementing blockchain

4. Discussion and conclusion

ISM model which is shown in Figure 1 presents 12 selected challenging factors and their relationships to the implementation of blockchain solutions in the finance industry in Sri Lanka. It depicts that lack of trust in new and immature technology (C1) as the root challenging factor for implementing blockchain in the financial industry and has a great influence on other challenges. Lack of regulations (C5), lack of standardization (C2), interoperability issues with legacy systems (C11) and Cost of implementation (C8) are also having a greater influence on blockchain implementation. Challenges due to legal issues (C3) and lack of expertise (C7) have to be addressed in order to promote the technology and a national level initiative may be required to develop the legal framework for the finance sector to further expand blockchain technology solutions and to strategize a talent development plan. Inadequate training opportunity (C4) is another factor that the finance sector has to be serious about and creating more training opportunities within an outside organization would help to ease those challenges.

In this study, we proposed an ISM based model to analyze the influence of challenging factors in implementing blockchain technology in the finance sector in Sri Lanka and used ISM to determine the relationship between challenging factors identified in the research. According to the study, lack of trust in new and immature technology (C1), Lack of regulations (C5), lack of standardization (C2), interoperability issues with legacy systems (C11) and Cost of implementation (C8) are the main challenges to overcome when implementing blockchain solutions. Furthermore, it is recommended that a greater emphasis is required to collaborate with educational institutions and training providers to build the quality human resources required for the technology transformation. Creating appropriate awareness of emerging technologies and their benefits among the workforce would benefit to get their support for these initiatives. As further enhancements of this research, empirical validation of the ISM model can be done with the aim of developing a generic model. Future research also can explore the possibility of classifying challenging factors into major categories and rank those challenges by their significance level of influence.

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