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Journal of Computer Information Systems

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/ucis20

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To cite this article: Sujeet Kumar Sharma, Yogesh K. Dwivedi, Santosh K. Misra & Nripendra P. Rana (2023): Conjoint Analysis of Blockchain Adoption Challenges in Government, Journal of Computer Information Systems, DOI: 10.1080/08874417.2023.2185552

To link to this article: https://doi.org/10.1080/08874417.2023.2185552

Published online: 18 Apr 2023.

JOURNAL OF COMPUTER INFORMATION SYSTEMS
https://doi.org/10.1080/08874417.2023.2185552

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Conjoint Analysis of Blockchain Adoption Challenges in Government

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ABSTRACT
This study identifies the critical challenges for blockchain adoption in government, and more specifically in the delivery of public services in the state governments of India. A literature review and focus-group with stakeholders was conducted to identify critical cfhallenges. Each challenge was ranked based on the opinions of stakeholders using conjoint analysis. Regarding government adoption of Blockchain, this study points to ecological shifts as a more significant challenge than technology. This study provides theoretical implications for researchers and valuable insights for practitioners.

KEYWORDS
Blockchain; government; conjoint analysis; India

Introduction

Blockchain has impacted government organizations and the masses since its introduction in 2008 by Satoshi Nakamoto.[1–3] Governments have shown a deep interest in investing in blockchain systems, and expect an early return on investment with respect to business value and greater citizen satisfaction.[1–3] Blockchains are distributed, open and transparent systems that make it almost impossible to corrupt information.[3] Blockchain distributes identical copies to all nodes that have been verified by all stakeholders to ensure data integrity.[3] The cryptography works in the background to ensure the integrity of the data that is stored on the Blockchain. Because this data is tamper-proof, it can be shared with the public for consumption. Blockchains are primarily designed for storing transactional data. Governments are piloting some Blockchain applications to store data related school/college certificates, farmer loans, vehicle registration, and land records.[4] In addition, governments are motivated to adopt Blockchain, because the technology reduces transaction costs and makes government processes more efficient.[5]

Corruption increases costs and reduces access to services and is a major challenge that affects citizens, especially the poor.[6] Around the World, trust in public institutions is reaching new lows.[7] For example, the percentage of people trusting Government is 33% in France, 36% in the UK, and 34% in Spain.[7] Pew Research Center[8] reported in 2019 that public trust in USA-government is at an all-time low of 17%. Transparency International released the corruption perception index (CPI) at the World Economic Forum 2020, where India ranked 80 out of 180 countries.[9] Trust is inextricably linked to the legitimacy of governments and plays a crucial role in keeping governments and citizens connected. Researchers have identified citizen trust is one of the major challenges government IT projects.[10] Blockchain seems to be the perfect solution for building a bridge of trust between citizens and governments, as it is considered a trust machine.[11] Surprisingly, governments have been slow to adopt blockchain technology. Despite the fact that bitcoin has been around for more than a decade, it is rare for a government to adopt Blockchain on a large scale. It is important to understand why governments are slow to embrace Blockchain.

Researchers[12] argue that organizations need to understand and solve blockchain adoption challenges, as it is a new-generation technology. This study attempts to understand the challenges of blockchain adoption in India (public service delivery). We adopt the technological, organizational, and environmental (TOE) framework[13] as the theoretical basis to classify the blockchain adoption challenges and conjoint analysis for their ranking. We propose the following research question-

RQ: *What challenges of blockchain adoption in governments and their relative ranking will lead to a sustainable strategy for blockchain adoption?*

Findings will contribute to the literature on strategies to mitigate technology adoption bottlenecks.[14]

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In addition, by identifying adoption challenges and their ranking, the study will also help government decision-makers develop effective strategies for smoothly integrating blockchain systems into government processes.[15]

The remaining sections of the paper are structured as follows. Section 2 presents the literature on Blockchain in Government and identifies and synthesizes the challenges to blockchain adoption. Section 3 details the research methodology. Section 4 discusses the findings and implications. Chapter 5 presents limitations and research directions. The conclusion is presented in section 6.

Literature review

Blockchain is "a distributed peer-to-peer ledger comprising an ordered set of connected and replicated data blocks."[16] Government blockchains differ from public blockchains like Bitcoin and Ethereum. We provide a brief overview of government blockchains below.

Government blockchains

Key features of Government-blockchains are:

(a) They are private permissioned Blockchain but with viewing rights to everyone (protected in some cases and open in others)
(b) Government-designated nodes exclusively do the block writing and ordering
(c) They connect different, often disparate, databases

Governments seek to benefit from 3 critical features of Blockchain -

(a) Protection against an "insider job" – immutability feature
(b) Efficient e-Verification of documents issued on Blockchain
(c) The provenance of a given asset (e.g., real estate)

Where Government-Blockchain differs from public blockchains –

(a) No "miners" on their blockchains in the Bitcoin sense
(b) Not likely to freely downloadable public "Distributed Ledgers."

Blockchain can develop a trustworthy ecosystem within governments. Governments can realize time and cost savings by successfully adopting Blockchain into their functioning.

Blockchain in government

As Blockchain's potential becomes more apparent, the excitement around the technology is increasing. The list of government blockchain applications continues to grow across the globe.[1] Governments in India are experimenting with blockchain-based land registries that involve multiple parties to securely store registry copies.[4] For example, Amaravati, the capital region of Andhra Pradesh, where 0.1 million land records have been stored on the Blockchain to ensure the immutability of the data.[17] In the USA, the Government has used blockchain technology to create a secure, tamper-proof voting system. For instance, West Virginia became the first US state to hold its midterm elections on a blockchain platform,[18] which led to a secure and successful election. Across the United Arab Emirates, governments are turning to blockchain technology for supply chain management to track the movement of goods from producer to customer, thereby increasing transparency and reducing corruption. The Dubai government,[19] for instance, is working on a blockchain-powered platform that will track food supply chains and ensure safety and quality. Blockchain infrastructures are secure by design, and data sharing can be initiated when criteria are met in a transparent and automated manner.[20] Blockchain's characteristics encourage governments to use trusted services for everyone's benefit.[21,23] Although blockchain technology is still in the early stages of being adopted in government services, it is clear that this technology has the potential to revolutionize the way in which governments operate and interact with their citizens.

TOE framework

The extant literature noted that the adoption and implementation of technology innovation are influenced by technological, organizational, and environmental factors.[24] The technological, organizational, and environmental (TOE) framework[12] is the widely adopted model to study the adoption of technology innovation. Technology represents both internal and external technologies needed for the organization. The organizational component represents the company's characteristics, size, and other relevant resources. The environmental component represents the domain where the company operates and includes industry characteristics.

Identification of key challenges in blockchain implementation in government

Blockchain adoption in an organization is a challenging task.[25] Blockchain challenges differ for private and public organizations due to their inherent characteristics. In government services of developing countries, developing an effective strategy successful blockchain implementation is challenging, where process-standardization is the bottleneck. Therefore, understanding blockchain adoption challenges are critical for policymakers. In the first stage, we searched two databases: Scopus and Google Scholar using the keyword search shown in Figure 1. We then finalized a set of 15 challenges related to blockchain adoption, using a cutoff of 8 as the number of occurrences.

In the second stage, we used convenience sampling to select a group of five members who were experienced in implementing technology in Government. We presented identified challenges with the experts using zoom video call. The group of experts agreed to retain 12 challenges after extensive deliberations. We categorize and synthesize literature related to each identified challenge using the TOE framework in the following sub-sections.

Technological challenges

(1) ***Design issues***: Core functions of the Blockchain require specific design consideration, including whether the Blockchain is public, private, or hybrid. The public Blockchain is generally open to anyone. The private Blockchain involves limited participation and permission structures, whereas a hybrid blockchain has both public and private designs. An effective design of blockchain systems supports transparency in governance.[26,27] Nodes, users, and validators of the Blockchain are different entities. Blockchain nature will indicate if it should be comprised of only trusted partners, a group of participants, or regulators, including consumers or the members of the public.[28] However, the design choices can lead to performance issues growing in terms of the number of transactions.[29]

(2) ***Process change cost:*** Blockchain systems are estimated to impact business process change and technology adoption by 80% and 20%, respectively.[30] Some business processes and government regulations must change to accommodate blockchain transactions. For example, the costs of training, auditing & technical support highlight the importance of governance processes that highlight the changes required to implement this technology.[31,32] Although the cost of process change is not generally a primary financial concern for governments, it could be a significant challenge for resource-constrained governments. Rindfleisch[33] argued that transaction cost theory suggests that conducting transactions is an expensive process (e.g., negotiating contracts, overseeing performance, and resolving issues) and various modes of organizing transactions (e.g., within governments). Transaction costs for governments arise when dealing with external parties when adopting Blockchain. These include search and information costs to find the right providers,

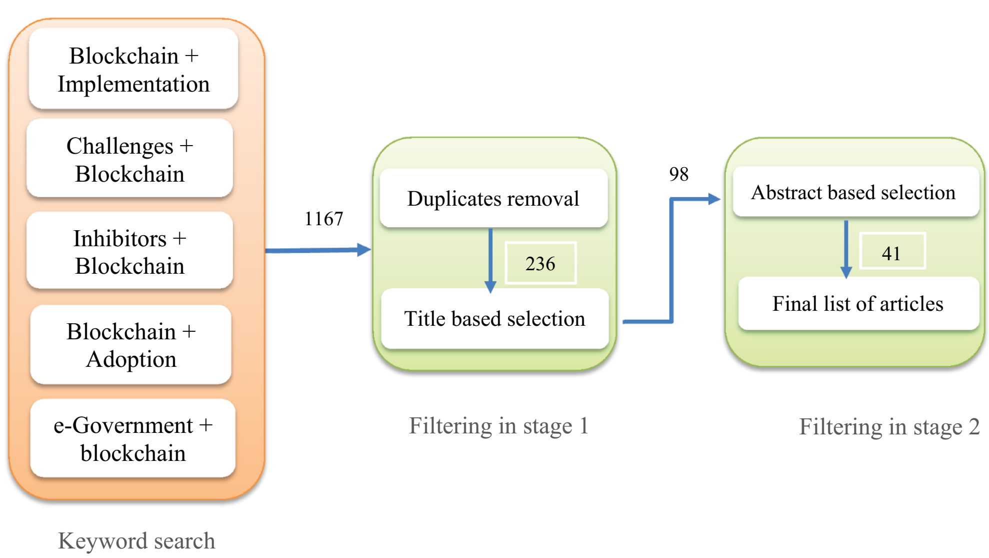

Figure 1. Literature selection process.

negotiation and decision costs related to various technical devices to set up the technology, and police and enforcement costs to monitor the blockchain adoption quality.[34]

(3) ***Low throughput rate***: Blockchain can process a limited number of transactions per second.[35] Researchers[36] claimed that 7 transactions can be performed in one second in case of the bitcoin blockchain, which is significantly low compared with VISA (on an average 1700 per second). Transaction throughput, one of Blockchain's most talked-about performance metrics, has not reached a satisfactory level in the current blockchain systems and leads to an unpleasant user experience quality.[37] Low throughput is one of the key challenges for blockchain adoption,[38] depending on several factors, such as the consensus mechanism used, the number of validators, and the complexity of blockchain applications.

(4) ***Scalability***: Scalability is another critical challenge in blockchain adoption.[17,39,40] There are two scalability concerns, capacity and networking. It is essential to store large amounts of transactional data from latest block to genesis block in Blockchain, while storage capacity of each node in Blockchain is limited.[36] Regarding the network: When a transaction is first initiated, it is shared with all nodes. Again, when a block is mined, it is shared with all nodes. This process consumes significant network resources and therefore introduces a delay, which requires innovation in the data transfer mechanism.[36] Scalability is a key challenge. It depends not only on throughput, but also on other factors such as block size, chain size, and digital signature.[41] If blockchains are used to deliver public services, the number of transactions will increase significantly. This larger block size in Blockchain will increase the required transaction per second, which can choke Blockchain with transaction stop. As the public Blockchains are accessible by millions of users and it will have more number of nodes, the transaction speed will be comparatively slower and that's why there is higher possibility of scalability issues in public Blockchains. However, private blockchains only deal with a few nodes, helping to manage data more efficiently.[42]

(5) ***Security***: Blockchain technology is largely seen as secure.[43,44] However, it has its own security issues that, if unaddressed, could harm businesses.[40,45] A 51% attack is a critical blockchain security issue. In this attack, most of the Blockchain's hash rate is controlled by one or more malicious entities. The hashing rate is a measure of the computing power associated with the creation of new coins. Well-known cryptocurrencies like ZenCash and Verge were victims of such attacks, with attackers taking $20 m due to blockchain security issues in 2018. In 2018, blockchain security issues witnessed a massive loss of $900 million. Security concerns are a critical shortcoming limiting blockchain adoption in Government.

Organizational challenges

(1) ***Capacity building***: The acute shortage of skilled workers in Government is another major challenge to the adoption of new technologies.[46] The intended benefits of new technologies for government service delivery could be compromised unless capacity issues are addressed. Failure to address these issues could lead to reduced government effectiveness and increased operational costs.[47] The same condition applies to blockchain systems, as capacity building to understand blockchain know-how to function effectively depends on training government staff to improve their competencies. Stewart[48] proposed a theory of change to increase officials' capacity to access, evaluate and use research evidence in policy-making. Capacity building is needed in all the major organs of Government, such as the executive, legislature and judiciary.

(2) ***Technical skills***: Blockchain has become central to various industries, from healthcare to public service delivery to supply chain companies.[1] The demand market has outstripped the supply market in the search for blockchain talent. Technical skills are essential to overcome the early challenges of blockchain adoption.[32] Companies needing talent to develop and implement blockchain applications are facing a shortage of developers with the necessary skills to create high-quality applications. Business Insider's recent report[49] also reflects the demand for technical skills in Australia and Asia in recent years. Furthermore, blockchain technology is now being seriously considered equally by governments, agile startups and local businesses. The large salary premium for blockchain developers in the private sector means that the Government will have a hard time recruiting blockchain professionals, as there is a fixed pay scale for all grades.

(3) ***Resistance to change***: User acceptance of new technologies is seen as an important goal when

implementing them. Although there are different perspectives on change resistance, there is agreement that understanding and exploring change resistance to technology adoption is an important research area. Research recognizes that better theories of user resistance can lead to better technology implementation strategies and outcomes.[50] Joshi[50] proposed a model to explain resistance to change using equity theory. For example, when change benefits users, they readily accept it. However, if the change is unfavorable to them, they will resist it. Employees' main concern about new technologies is potential job loss.[46] Some studies[1,22,40] also discuss resistance to change as a challenge to blockchain adoption. Primary concern among employees related to new technology is the possibility of job losses.[46] A handful of studies[1,22,40] have also discussed resistance to change as a challenge for blockchain adoption. Governments face an even greater challenge in effectively adopting Blockchain, not only ensuring that government employees have the right skills and training to implement it successfully, but also that their citizens have the necessary knowledge and confidence to use the technology.

Environmental challenges

(1) ***Lack of awareness***: Perceived awareness is believed to influence citizens' adoption of new technologies by informing them of their benefits and credibility.[51] Lack of awareness is one of the main concerns associated with adopting new technologies.[52,53] Based on the above arguments, the authors contend that successful adoption of Blockchain is not possible unless users of this technology are aware of the benefits of the new technology. As Blockchain is relatively new, lack of awareness affects its widespread adoption.[54]

(2) ***Enabling legislative support***: Lack of legislative support is one of the key challenges for governments in effectively implementing blockchain.[46,55,56] Attention toward using Blockchain, in public and private enterprises has grown significantly in India in recent years.[57] However, the Government of India (GoI) places great emphasis on promoting digital economy as it has the Indian Contract Act 1872 and IT Act 2000, which provide a conducive legal environment and strong foundation for Blockchain implementation. However, the GoI is yet to address the challenges in the way of smart contracts in the case of Blockchain. For example, the IT Act 2000 does not include land registration within its purview and this needs to be changed if the blockchain-based land transactions require authentication and recognition. The regulatory framework[55] and the active role of the senior management in the Government will determine the pace of the penetration of Blockchain in the public sector.

(3) ***Legal issues***: In e-government, digital signatures need to be formalized and recognized by law.[46] Digital signatures are becoming the new normal in the current context. When it comes to Blockchain, existing legal practices need to be reviewed as this technology can cross jurisdictional boundaries as nodes in a blockchain are not restricted by location. This can raise a number of territorial issues that require careful consideration of contractual relationships.[1] For example, in a traditional environment, if the bank is involved in fraudulent activity, it can be sued and specific legal action taken based on jurisdiction. However, applying the same rules in a decentralized blockchain environment may be difficult. It could be difficult to determine the location of fraudulent and erroneous transactions.[58] As Blockchain resides on a decentralized ledger on a network of different computers, it is necessary to determine where the contract was formed to know which law applies to enforce the agreement. For public blockchains, where multiple smart contracts are formed by multiple stakeholders, the legal issues are critical.[14]

(4) ***Collaboration among government agencies***: Governments worldwide are realizing Blockchain's potential to deliver better services to citizens with transparency and accountability. To achieve this, government agencies need to collaborate and share data with other agencies, while ensuring that the data they hold is secure remains a challenge. However, government agencies often work in silos, and the data they tend to share is not compatible with blockchain platforms, so sharing data with other government agencies is a serious concern. In order to facilitate collaboration within organizations and across industries, governments need to redefine their organizational strategies.[40] In addition to their willingness to share their data, they need to streamline their processes to address issues of granularity, stack, structure and technology compatibility.[59] Governments must develop frameworks so that different agencies can use their shared data for effective and efficient decision-making.

Research methodology

Conjoint analysis is the research method used in this study to rank the challenges in order to help policy-makers develop effective strategies.

Research context (blockchain adoption in government services)

India is a federal union with 28 states and 8 union territories. Some state governments, such as Maharastra, Tamil Nadu, Telangana, and Andhra Pradesh, are experimenting with delivering services to citizens through a blockchain platform. For example, a project to validate caste certificates using Blockchain has been initiated by the Government of Maharashtra.[60] In the case of the Tamil Nadu government,[61] a US$6 million project has been announced for the rollout of a blockchain network across the state for a population of 80 million people. The citizens will use this network to store certificates issued by the Government such as income, municipality, college, and school certificates, among others. Other state governments have undertaken similar blockchain initiatives in India to deliver services to their citizens transparently and securely. The state governments are investing in blockchain technology infrastructure, which will act as the technological backbone and can be shared with other agencies of the state government and the central Government. It is envisioned that it will create a vibrant ecosystem for private sector stakeholders, particularly start-ups, to create value by delivering transparent and trusted services for the citizens and the Government.

Method and data collection

Conjoint analysis, a multivariate statistical technique, has been used extensively in marketing research since the 1970s to understand the relative importance of features and trade-offs consumers consider when purchasing a product or service. Specifically, conjoint analysis is used to obtain information about how users rate different product features overall.[62,63] For example, if we assign equal weight to each challenge, each challenge would contribute approximately 8.3% to Blockchain adoption in Government. Conjoint analysis facilitates the elicitation of individual responses. We assume that multiple challenges will be addressed simultaneously to realize Blockchain adoption in Government. The relative importance of each challenge can be calculated and understood using the methodology adopted. We conducted a pilot test of the survey questionnaire by emailing it to three experts involved in government blockchain use cases, and two professors who do research in the field of Blockchain. This pilot study aimed to determine how much time it would take to complete this survey and to get feedback. We emailed the attributes and levels of the challenges identified to the experts. They reported difficulties in ranking the profiles of the different orthogonal combinations, which were generated using SPSS 24.0 software.

Based on the feedback, we developed a heatmap of the profiles and sent it back to the experts for another round of feedback. This time the experts were satisfied, but had suggestions for further improvements. The profiles were then restructured. The final versions of the profiles are given in Appendix A. This study conducted a survey across states in India. The sample population consisted of information technology secretaries, CEOs, CTOs, chief architects, blockchain center heads, and research professors. We sent personal e-mails to all experts (we could identify) involved in planning/implementing Blockchain in the Government in India to know their willingness to participate in the survey. In February 2020, we sent questionnaires to 214 individuals that agreed to participate in our study. We received 19 responses in the first wave of data collection. We then sent reminder e-mails for follow-up in May 2020 to those who had not responded and received 11 more responses in the second wave of data collection. In the third and final data collection wave, we sent a final reminder in August 2020, receiving 16 additional responses. We received 46 valid responses, giving a response rate of 21.49%. Studies in the existing literature have reported that web surveys typically result in lower response rates, including incorrect and blocked e-mail addresses.[64] The response rate was close to the recommended minimum of 20% for organizational surveys.[65] There is no minimum sample size required to conduct conjoint analysis.[65] Table 1 provides details of the respondent profiles participated in the survey.

Data analysis and results

We began data analysis by testing for sample non-response bias (respondents vs. non-respondents) by comparing data collected from respondents in three waves. We conducted homogeneity of variances using analysis of variance (ANOVA) by comparing first, second and third wave responses, finding no statistically significant difference in means (see Appendix B) of results. We can conclude that there is no significant sample non-response bias. Next, we conduct a conjoint analysis to calculate the relative importance of each challenge. The SPSS package

Table 1. Respondents' profiles for the conjoint analysis.

Designations	Organization	Number
IT secretaries of state government	Government/public	02
CEOs of blockchain technology companies implementing government blockchain projects	Government/public	04
CEOs of blockchain technology companies implementing government Blockchain projects	Private	01
CTOs of blockchain technology companies implementing Government Blockchain projects	Government/public	10
CTOs of blockchain technology companies implementing Government blockchain projects	Private	02
Principal architects, heads of blockchain units	Government/public	19
Principal architects, heads of blockchain units	Private	02
Not mentioned	Not mentioned	06
Total		**46**

does not provide a menu-driven option for conjoint analysis. We wrote a software code (see Appendix C) for the execution of conjoint analysis in the SPSS package. We created two separate SPSS files to meet the necessary requirements. First file stored orthogonal combinations of all 12 blockchain adoption challenges, second file stored respondents' preferences. The codes used for each challenge in the SPSS program (conjoint analysis) are presented in Table 2. Finally, we performed the conjoint analysis; the results are presented in Table 2.

Next, we go on to discuss what emerged. We found that the need for capacity building (13.56%), enabling legislative support (13.34%), lack of sufficient awareness (10.92%), resistance to change (10.62%), and throughput (9.45%) are the five most important attributes (challenges) to blockchain adoption in Government. Combined, these five challenges contribute 58% to blockchain adoption in Government. Cumulatively, the following three challenges contribute 23% to the impact of challenges faced in blockchain adoption: security (8.66%), legal issues (8.16%), and lack of technical skills (6.18%). These three challenges can be prioritized after addressing the five challenges mentioned above, resulting in some of them being reduced in intensity. For example, better legislative support helps address the capacity-building challenge, thereby considerably reducing the technical skills shortage. The following two critical challenges are design conflicts, standardization and interoperability (6.08%), and collaboration between government agencies and departments (4.56%). These challenges are important, but can be considered low priority. Finally, the challenges with the lowest impact were scalability (4.52%) and the cost of a process change (3.96%). These challenges will have an impact, but to a lesser extent, due to the nature and size of governments.

Discussion of findings and implications

A deeper examination of the results provides exciting insights for adopting Blockchain in Government (public service delivery). The following suggestions can be considered by governments ready to adopt Blockchain in their public service delivery.

Ecosystem change is a bigger challenge than the technology

Our findings suggest that the biggest hurdle for governments is gaining a sufficient understanding of the technology to reap its benefits, despite Blockchain being a highly complex technology. The top challenge for blockchain implementation is building the ecosystem. The top three blockchain adoption challenges—capacity building, legislative support, and awareness raising (see Table 2) - are related to building a blockchain ecosystem. Therefore, governments implementing blockchain solutions should focus on creating an ecosystem for Blockchain. This would include creating a supportive

Table 2. Conjoint analysis results.

Challenges of blockchain adoption in Government	Importance (%)
Need for capacity building (CB)	13.56
Enabling legislative support (LS)	13.34
Lack of sufficient awareness (Awareness)	10.92
Resistance to change (RC)	10.62
Throughput rate (TR)	9.45
Security (Sec)	8.66
Legal Issue (LI)	8.16
Lack of technical skills (TS)	6.18
Design issues (conflicts, standardization, and interoperability) (DI)	6.08
Collaboration among government agencies and departments (Coll)	4.56
Scalability	4.52
Process changes cost (PCC)	3.96

legal framework, raising awareness of the technology, and building appropriate blockchain technology capacity within Government. Creating this blockchain ecosystem would facilitate private capital and entrepreneurship to participate in Blockchain, making the ecosystem adaptable, flexible, and tailored to people's needs. The Government should focus on creating a blockchain infrastructure that enables startups, private ventures, and governments to interact and provide value-added services to citizens using this technology in its vision for blockchain implementation.

Process change cost is inconsequential

Another interesting finding from our research is that the cost of changing processes is not a major concern for governments. One would expect that for resource-constrained governments, process change cost would be a significant barrier to blockchain adoption. However, it turns out that process change cost is not significant at all. It ranks 12th out of 12 factors based on senior executives' opinions in planning/implementing Blockchain in governments. There could be two reasons for this: Firstly, the total cost of implementing blockchain technology is insignificant given the size of the government budget; secondly, policymakers are confident that the efficiency gains and resulting savings from implementing this technology will far outweigh the expenditure.

Throughput rate remains a significant concern

Most technical challenges, such as design issues, scalability, standardization, interoperability, and security, do not appear in the top five. However, the throughput rate is an exception. The throughput rate refers to the number of transactions possible per second on the Blockchain. Blockchain transactions are typically slower than traditional database transactions. Transactions can slow down considerably depending on the underlying technology and consensus protocol. For example, one Ethereum-based implementation claims 2,000 TPS (transactions per second) as normal throughput. This may be too slow for government transactions, especially if multiple services will be offered on a shared blockchain infrastructure.

Technical challenges are less significant

Our findings suggest that technical blockchain challenges are not the most important in government blockchain implementation. And while issues such as design conflicts, interoperability, standardization, scalability, and security are important, their magnitude is small. This is surprising because Blockchain is a complex and rapidly evolving technology. These findings contrast with the challenges identified in Working Paper,[26] which identifies technological challenges as one of the main barriers to adopting Blockchain in Government.

Theoretical implications

This study offers some valuable theoretical implications. First, this study adopts the TOE framework to classify the challenges of blockchain adoption in government services. Technological constructs such as design issues, scalability, and low throughput are novel contributions to TOE framework. These technological constructs influence blockchain adoption decisions by interacting with organizational and environmental constructs. Second, this is the first study that uses conjoint analysis to study the phenomenon of blockchain adoption, ranking the identified challenges. This novel contribution would help the wider IS community understand the magnitude of the challenges of blockchain adoption in Government, and contribute to the literature on IS implementation planning. Finally, the methodology of this study will encourage information systems researchers to have a better understanding of the complex phenomenon of the adoption of emerging technology.

Practical implications

This study offers two practical implications.

First, this study identifies the challenges of blockchain adoption in Government. This will help decision-makers to align the information system (IS) strategy with the organizational and business strategy.[66] From a strategy perspective, an organization's IS, and business strategies must be aligned when adopting Blockchain applications as an information system. The celebrated information systems strategy triangle[65] shows the interrelationship between IS, organizational, and business strategies. For any organization to be successful, its information systems strategy must be in complete harmony with its business and organizational strategies. Any change in one will necessitate a recalibration of the other. For a government, deciding to adopt blockchain technology to deliver its public services is a major shift in its information systems strategy. Governments build information systems with centralized architecture and hierarchical control, and moving into distributed ledger technology territory without centralized control is a huge leap of faith. However, it is essential to recognize that blockchain governance is not necessarily completely distributed. Many researchers[17,42,56] have found that blockchains offer participants unequal power over governance frameworks depending on how they are implemented, for example, permissioned or permissionless. In the case of governments, Blockchain still represents a significant change in their IS and, consequently, their organizational strategy, as it requires a change in existing workflows and the relinquishment of some controls. A public blockchain would also introduce a different level of transparency into the operations of the Government. All of these will require changes in the Government's organization and business strategy.

Second, in order to mitigate the identified challenges of blockchain adoption in the highly dynamic scenario, governments can take two different approaches to blockchain adoption – 1) select an appropriate use case and implement a pilot using Blockchain technology, or 2) take a comprehensive view and implement a common Blockchain infrastructure: Blockchain as a Service (Baas). In the case of the pilot-based approach. Many state governments have adopted this approach in India, such as Telangana, Maharashtra, Tamil Nadu, and Karnataka. Each of these governments is piloting the use case for Blockchain: Karnataka for authentication and certification, Maharashtra for cotton trade, and Telangana for land registration. The use case-specific implementation does not require a significant change in the Government's IS strategy as the impact of the technology is limited to a narrow sub-sector, requiring no system-wide change management strategy. In the Baas approach, the Government invests and creates a common Blockchain infrastructure multiple stakeholders use to deliver value to citizens. Thereafter, all government departments can use the Blockchain without investing. This is the approach taken by the Government of Tamil Nadu (India). The Government has invested in a common blockchain infrastructure that everyone can use rather than allowing each department to experiment with its blockchain implementation. The infrastructure approach also addresses one of the key challenges of blockchain implementation in Government: lack of capacity. It is better to equip the e-governance department to handle the technology on behalf of all user departments rather than expecting every government department to build sufficient technical capacity to use a technology as complex as Blockchain. This study suggests that "Blockchain as infrastructure" should be the preferred approach for governments looking to implement Blockchain-based solutions. The best way to implement Blockchain would be to create an ecosystem that encourages private and public actors to collaborate and share information to innovate and develop value-added services for citizens. This approach would need to be carefully considered, as it involves managing change across the Government and carries strategic implications for it. Suppose the Department of Health plans to use blockchains for electronic medical records. In that case, the state must provide legal sanctity for the information transferred on the blockchain infrastructure so insurers can operate.

Limitations and research directions

This study has some limitations that could be addressed by future research. First, this study identifies and ranks the challenges impacting blockchain adoption in Government, based on the views of senior and mid-level executives. This work can be expanded through the inclusion of input from other stakeholders, such as end-users. Second, the conjoint analysis uses attributes and their levels to determine the relative importance of attributes. In this study, three levels (low, medium, and high) were used, and future research could use five levels to rank the challenges identified to provide more in-depth insights. Third, the challenges identified in this study can be considered in new contexts, such as the impact of blockchains on climate change[67] and the challenges of using blockchain solutions to secure the metaverse.[68,69,70] Finally, researchers can use the ISM methodology to develop a theoretical model of the challenges of blockchain adoption.

Conclusion

In this study, we used a literature review and focus group discussions with senior and mid-level executives to identify and rank the challenges of blockchain adoption in the government sector. We used conjoint analysis to rank the identified challenges of blockchain adoption. The study grouped the challenges into clusters based on their scoring, providing a robust discussion for practitioners. In addition, this study has presented the theoretical implications for the researchers. We have concluded this study with some limitations and directions for future research.

Acknowledgments

Open Access funding provided by the Qatar National Library.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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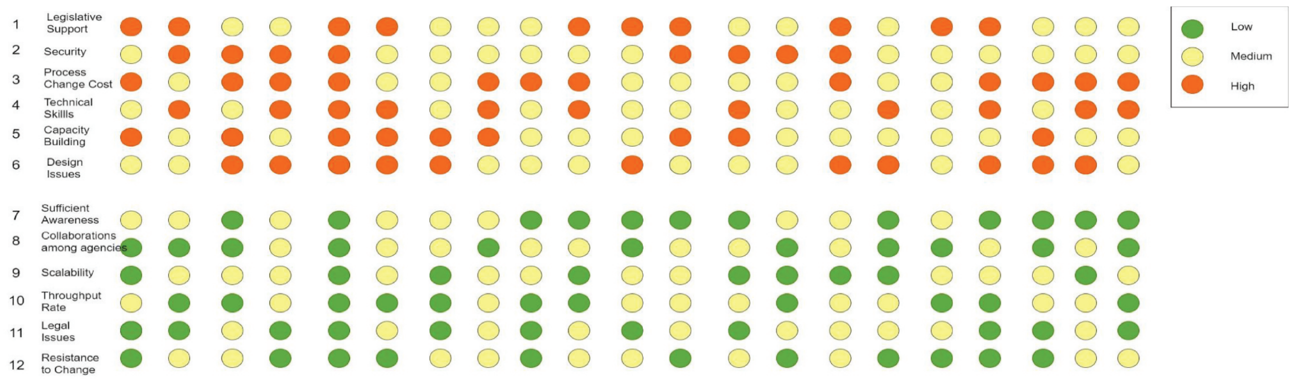
Appendix A: Final version

Survey: Blockchain adoption challenges in government services in India

Blockchain Adoption challenges in public service delivery	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5	OPTION 6	OPTION 7	OPTION 8	OPTION 9	OPTION 10	OPTION 11	OPTION 12	OPTION 13	OPTION 14	OPTION 15	OPTION 16	OPTION 17	OPTION 18	OPTION 19	OPTION 20	OPTION 21



Rank of each option (1 to 21) 1- best																					

Section 2:

Name: Designation: Organization: Company URL:

Appendix B: Test of homogeneity of variances

	Levene statistic	df1	df2	Sig.
Pref1	2.606	2	43	0.085
Pref2	2.448	2	43	0.098
Pref3	2.124	2	43	0.132
Pref4	2.281	2	43	0.114
Pref5	0.040	2	43	0.961
Pref6	2.818	2	43	0.071
Pref7	0.128	2	43	0.880
Pref8	0.400	2	43	0.673
Pref9	0.499	2	43	0.610
Pref10	1.432	2	43	0.250
Pref11	2.929	2	43	0.064
Pref12	0.514	2	43	0.602
Pref13	1.670	2	43	0.200
Pref14	0.951	2	43	0.394
Pref15	2.303	2	43	0.112
Pref16	0.197	2	43	0.822
Pref17	0.986	2	43	0.381
Pref18	2.155	2	43	0.128
Pref19	0.446	2	43	0.643
Pref20	0.696	2	43	0.504
Pref21	2.408	2	43	0.102

Appendix C: Conjoint analysis code

```
CONJOINT PLAN = 'Desktop:\Conjoint Part I.sav'
/DATA = 'Desktop:\Blockchain Conjoint.sav'
/SEQUENCE = Pref1 To Pref21
/SUBJECT = RespID/FACTORS = Awareness (DISCRETE) CB (DISCRETE) LS (DISCRETE) DI (DISCRETE) PCC (DISCRETE) Coll (DISCRETE) Sec (DISCRETE) Scalability (DISCRETE) TR (DISCRETE) TS (DISCRETE) LI (DISCRETE) RC (DISCRETE)
```