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Blockchain adoption in higher-education institutions in India: Identifying the main challenges

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Abstract: This study aims to understand the challenges in adoption of blockchain technology in higher education institutions in India using the technological-organizational-environmental (TOE) framework. Blockchain brings transparency, efficiency in working systems, and leveraging trust. The benefits of blockchain are multifaceted and might be beneficial to educational institutions. However, the utilization of blockchain technology is presently in its nascent stage within the educational sector in India. This research employed a qualitative methodology involving semi-structured interviews with participants working in higher administration teams and IT teams in private universities in the Delhi-NCR region of India. The responses of the participants were analyzed using thematic analysis. The study found 10 main challenges that were categorized under the three dimensions of the TOE framework.

Subjects: Information & Communication Technology (ICT); Legal, Ethical & Social Aspects of IT; Management of IT

Keywords: blockchain; technology adoption; higher education institutions; data privacy and security; environment; India

1. Introduction

Blockchain was initially deployed to manage the business of cryptocurrency way back in early 2000, it is now a technology with multiple benefits for all business sectors (Arndt & Guercio, 2020). The biggest advantage of Blockchain technology, other than the decentralization of data, is that it is considered as one of the most trusted platforms for building secure data network and it cost effective as it removes intermediaries in distributed applications. It also offers the advantage of creating secure data that cannot be tweaked by anyone, once the data is entered in the public ledger (Bhaskar et al., 2021). Thus, building a structure for blockchain technology with strong cybersecure capabilities has applications for every business sector and is highly in demand. More recently, higher education has become closely aligned with private sector commerce as a recipient and producer of commercial innovation (DuPont, 2021). However, the adoption of Blockchain technology in the education sector is not only in nascent stage but also making very slow strides (Kosmarski, 2020; Loukil et al., 2021; Mihaljević et al., 2023; Mohammad & Vargas, 2022). Despite speculations about the impact of Blockchain technology on the education sector, the present

understanding of its potential in many industries, including the educational sector, remains limited (Alipour et al., 2022; Dehghani et al., 2022).

The education sector across the globe is one of the largest growing sectors with significant social, technical, and economic challenges. Higher education is a multifaceted institution with deep-rooted incumbents and important cultural norms and traditions. However, the integration of digital technology in education has become a permanent fixture (Meyliana et al., 2020; Turnbull et al., 2021). Through the implementation of blended learning and flipped classrooms, students are no longer restricted by the educational resources and learning opportunities that are limited by the physical boundaries of their institutions (Phutela & Dwivedi, 2020). The present-day educational institutions encounter a pivotal obstacle in the form of the necessity to gather, preserve, and scrutinize data pertaining to each student's academic journey. This data encompasses the learning outcomes of individuals, their portfolios, and academic progression (Bayne et al., 2020). Employing blockchain technology in the realm of education offers both merits and demerits. The institution's ability to systematically arrange data across sundry departments will aid them in enhancing the retention and graduation rates of students (Razia & Awwad, 2022). Nonetheless, the principal challenge lies in comprehending the know-how of incorporating this technology into the pre-existing educational systems.

In view of the new technological disruptions, the recent amendments made in India's New Education Policy (New Education Policy, 2020), envision the transformation of the nation, building equitable and vibrant knowledge society, grounded on the pillars of high-quality education through enhanced use of digitalization and technology adoption. The New Education Policy (2020) aims to create global leaders from all diverse cultures and inclusivity, thereby allowing India to be recognized as a global superpower house of knowledgeable citizens (New Education Policy, 2020). To combat this, educational institutes now require to strategize building caliber for the same, and this is only possible when they have advanced technology embodied in their business model (Dash et al., 2022). Henceforth, this study aims to provide an insight on the dimensions which might obstruct institutional readiness to adopt Blockchain technology.

Despite all the literature available so far, adoption of blockchain technology in the higher education has not yet unlayered the other environmental forces like required infrastructure, adoption readiness and behavior, management willingness, required competencies, and finance, institutional task and objective, collaborations with other industries, and other environmental forces (Bhaskar et al., 2020; Mohammad & Vargas, 2022). Thus, this study aims to explore the key challenges faced by educational institutes in adopting the Blockchain technology by answering the following research questions:

(1) What are the current challenges in the adoption of Blockchain technology by Higher Education Institutes (HEIs) in India?
(2) In what manner do the technological, organizational, and environmental contexts pertain to these challenges encountered in the TOE framework?

2. Background of the study

2.1. New Education Policy and its relevance in industry 5.0

One of the biggest assets of any country lies in the number of educated people. Education is instrumental in building human capital and an equitable society. India since ancient period was known for its scholarly work and acquired knowledge by the educationists. India as one of the fastest growing economies will leverage young minds to place themselves in global market, enabling amalgamation of global trends in local flavors. With the expected lift in the country's GDP to $10 trillion by 2030, India will soon acquire the position of world's third largest economy, having a strong support of education behind it (Haque et al., 2023; MoHRD, 2014–2015). The fast-

paced growth of the education sector in India is shaping the new market and market trends. At present, India has approximately 890 public and private universities, and close to 40,000 higher educational institutes. After recent developments in New Education Policy (2020), government is envisioning a transformation in the structure of the whole of education and industry, leveraging better and competitive lifestyle. New Education Policy (2020) features the ambitious task of reforming the present education system as wider, holistic, flexi-to-access, welcoming diversity, inclusivity, and equality. The new NEP is founded on the pillars to support the sustainable development goals of the nation by inducting the concept of equity, accountability, affordability, access, and quality (Sharma & Pattanayak, 2022; Yadav et al., 2020). Education plays an important role in shaping the nation culturally, and technology developing a citizen of tomorrow. In lieu of this, the new education policy has introduced certain reforms to facilitate thought-provoking, well-rounded, and creative individuals' pursuing higher education.. Further, to achieve this government provisioned, that higher educational institutions should offer holistic and multidisciplinary quality education to the students. Further, many authors proposed that to transform the quality of education and to build powerful communities, it is essential for education sector to join hands with the technological advancements and make themselves ready for such adoptions. To take care of this, the government has proposed the establishment of an autonomous body, allowing experts to share their views on the adoption of technology in the education sector, facilitating quality education, assessment process, planning, and administration of academic activities. The vision of NEP can be be attained if institutions can create an environment ready to adapt to all new changes and trends emerging globally, and adoption of new age technology is one of them (Fedorova & Skobleva, 2020; Raimundo & Rosário, 2021).

2.2. Adoption of blockchain technology in higher education institutes of India

The unlimited benefits of Blockchain like transparency, immutability, security, and decentralized functioning allow its application and adoption in various sectors like banking, finance, tourism, public administration, and energy (Akaba et al., 2020; Alketbi et al., 2018; Mahankali & Chaudhary, 2020; Rashideh, 2020). Business services like education adopting Blockchain technology can lead to significant transformations in the education sector. Turkanovic et al. (2018) explained that how EduCTX used Blockchain technology based on different platforms creating the most trusted, decentralized credit transfer, and grading system in higher education, allowing the stakeholders to wholeheartedly accept the potential of Blockchain technology in HEI. Adoption of Blockchain technology in educational institutes highly depends upon the topographies and its usage in the sector. Analyzing the application of Blockchain technology in the educational sector has several benefits like sharing and distribution of certificates (Alsobhi et al., 2023), promoting collaborative learning environment (Bhaskar et al., 2020) to name a few. The education sector as one of the largest emerging sectors globally still has significant social, technical, and economic challenges (DuPont, 2021). Today's multifaceted educational institute is deeply rooted in cultural and traditional norms transforming from knowledge to skill-based teaching–learning program, education for all, better administration, and innovation/intervention by state or central governance having better policies (Aithal & Aithal, 2020). Additionally, learning methods are updated to keep up with the improvement in teaching–learning activity and to train future professionals increasing employability. Subsequently, the urge for higher education has increased and allowed development of new technologies and its adoption so as to enable learning to be more meaningful and impactful (Vig, 2022). Kamaludin et al. (2023) conceptualized the idea that digital transversal can probably support soft skills, new methods of teaching, and technologies in teaching and assessment methods, maintenance and distribution of certificate degrees and other important documents in connected network without tempering safety and security has to be aligned with nations' new education policy. In this reference, blockchain technologies based on educational functioning offer a complementary approach to monitoring learning quality (Fedorova & Skobleva, 2020). These technology solutions can eliminate inefficiencies by promoting transparency, trust, and collaboration (Mohammad & Vargas, 2022). In contrast to this, few authors visualize the application of Blockchain technology as a social appeal rather than just a matter of data handling (Kosmarski, 2020). Adoption of Blockchain in education sector offers several benefits like disbursement of

certificates, validation, and sharing of data in shared network (Bhaskar et al., 2021), and along with this, it will enable the employers in design the smooth processing of administrative activities (Clark, 2016). Gatteschi et al. (2020) identified the role of Blockchain as a tool to validate the authenticity and accreditation of the shared data, increasing the trust among the users. Further, Chen (2018) added the benefits of Blockchain technology in education sector by pointing out its potential usage in tracking the students' academic and professional journey.

The higher education sector is therefore a potential user for blockchain technology in terms of smart contracts (Nugent et al., 2016). With the recent addition of the Four-Year Undergraduate Program (FYUGP) as regulated by the New Education Policy (2020), students can now have the option to also make collateral entries. Henceforth, blockchain technology will have potential advantage for users to check the accreditation and validity of the owner's record further reducing the administrative complexities (Chen, 2018; Park, 2021). In contrast to this, many authors are apprehensive regarding Blockchain adoption in HEIs as they believe that adoption requires institutional capacity and competency to handle adoption eradicating future barriers, wherein institution lacks this competency (Ocampo et al., 2022; Raimundo & Rosário, 2021). Henceforth, there is a need to investigate further by collecting information pertaining to blockchain adoption and challenges faced, in order to pave the way for the future.

3. Theoretical framework

Rogers and Roger (1995) proposed that adoption of technological innovation in business practices usually alludes to the company's success in the future. Subsequently, many authors suggested multiple theories like Technology Acceptance model (TAM), Technology Assimilation theory (TAT), Perceived-Readiness model (PRM) on technological adoption based on the objectivity for the same (Armstrong & Sambamurthy, 1999; Molla & Licker, 2005; Venkatesh & Davis, 2000). However, in the present study authors intended to identify the driving force or barriers in adopting the technological advancements and innovations. The TOE framework comprehensively encompasses the different contexts of technology like user benefits, pre-requisites of resources and infrastructure, operational complexities, and safety as few of the factors likely to influence the adoption. In addition to this, TOE model encapsulates the brief idea of the context like organizational readiness termed as top management support and inclination for technology, size and structure of company, technological know-how by the company experts, its relevance for adoption, and sufficient availability of infrastructure (Dutta et al., 2020; Gangwar et al., 2014; Wang et al., 2010). The role of environment in the context of adoption is referred as the organizations' competency to face day-to-day operational challenges, strategies to cope up with industry dynamics, legal, governmental, and regulatory intricacies (Lippert & Govindarajulu, 2006). Tornatzky and Fleischer (1990), while processing on technological innovation, focused on Technology-Organization Environment (TOE) as an initial readiness of any organization to adopt the technology-based business practices. The TOE framework proposes the possibility of technological adoption when it receives support from organization, environment, and technology (Gangwar et al., 2014). Past studies which adopted the TOE framework in their investigation were mainly conducted in the field of cloud computing adoption, or to study the challenges faced by organizations during adoption of blockchain technology (Dutta et al., 2020; Ganguly, 2022), but there is a dearth of such research in the education sector, especially in the emerging markets.

4. Research methodology

This research employed a qualitative methodology involving semi-structured interviews, which was specifically chosen due to its ability to facilitate data collection without the limitations imposed by fixed-response queries (Arksey & Knight, 1999) and the flexibility it provides for open-ended questions (Vig, 2023). Initially, 10 target participants were chosen from the leading universities in the Delhi-NCR region of India, and they were subsequently requested to recommend other potential participants for the study (Silverman & Marvasti, 2008). The total number of participants was 27, working in higher administration teams and IT teams in these universities. Table 1 indicates the demographic profile of the participants. Interviews started with questions relating

Table 1. Demographic profile of participants

Demographic variable	Categories	No. of participants
Gender	Female	11
	Male	16
Age	30–40	10
	40–50	13
	50 and above	6
Work experience (years)	5–10	7
	10–15	14
	15 and above	6
Profile	Administration	18
	IT	9

to the profile and experience of the participants. Subsequently, participants were asked to provide insights on the technological, organizational, and environmental dimensions of adoption of blockchain in their institutions. Questions related to potential challenges or risks or benefits it may pose for educational institutions, its impact, and how educational institutions can prepare themselves to meet these challenges. The interviews were conducted telephonically and in person, as allowed by the participants and transcribed in writing simultaneously, followed by a meticulous qualitative analysis of the responses.

5. Data analysis

The present study utilized the thematic analysis method to analyse the transcripts of interviews with a view to identifying the converging themes. This method has been explained by Braun and Clarke (2006) as a "flexible and valuable research tool that has the potential to yield a comprehensive and intricate, albeit elaborate, account of data" (p. 5). Thematic analysis is a frequently employed approach to qualitative research, wherein the data is categorized into units of analysis (Fereday & Muir-Cochrane, 2006). Thematic analysis, according to Terry et al. (2017), "generates descriptions of patterns across the dataset." Examination of responses from each interview was performed, and it was compared with other responses to distinguish analogous themes (Ozcan & Eisenhardt, 2009). Common themes in the data were identified through codes, which were then reduced into categories, as shown in Table 2.

6. Findings and discussion

The study found 10 main challenges that were categorized under the three dimensions of the TOE framework. The conceptual framework of the study is presented in Figure 1.

6.1. Technological dimension

6.1.1. Operational issues

The findings indicate that blockchain technology is perceived as a complex technology. Many of the participants were not completely aware of the benefits or the uses of the blockchain technology in higher educational institutions. There is a widespread lack of understanding about how it works.

> Blockchain technology can be complex and require specialized knowledge. Participant 5

> To be honest, our awareness of the benefits of blockchain technology in the educational institutes in limited. We have heard about it, but its implementation appears to be very difficult and complicated. Participant 6

Table 2. Thematic analysis

Verbatim	First-order categories	Second-order themes	Aggregated themes
Blockchain technology can be complex and require specialized knowledge.	Technological complexity	Operational issues	Technological Dimension
Choosing the right blockchain platform and optimizing performance will be crucial.			
Challenge in ensuring interoperability with old and existing systems.			
Migrating existing academic records and data to the blockchain securely and accurately is a complex task that requires careful planning and execution.	Data migration		
There is a potential risk due to possibility of technical glitches.	Technical glitches	Security concerns	
Not aware about privacy features of blockchain technology.	Data privacy		
Adoption of blockchain technology might involve potential system upgrades.	IT system upgrades	Hardware-related challenges	
Infrastructure setup will be required for adoption of blockchain.	Computing resources		
Availability of high-speed internet connectivity and computing resources is needed.	High-speed internet connectivity		
Technical evaluation will be needed to ensure the chosen blockchain technology aligns with the existing IT infrastructure.	Alignment of IT infrastructure		
The initial investment required for blockchain implementation can be significant.	Investment in new technology	Cost of new technology	
Funding availability for technology upgrades may be limited.	Cost of future upgrades		
Resistance from stakeholders unfamiliar with the technology.	Resistance to change	Attitudinal issues	Organisational Dimension
Difficult to build confidence among various stakeholders.	Satisfaction of stakeholders		
Training and upskilling the IT team will be essential to ensure the smooth operation of the blockchain infrastructure.	Re-skilling and upskilling of IT teams	Human resource challenges	
Training sessions and awareness programs for staff members are required.	Training to staff		
Implementing and maintaining the blockchain solution would require a team of skilled blockchain developers, cybersecurity experts, and IT professionals.	Hiring of skilled professionals		
Hiring of skilled blockchain professionals can be costly.			
Shortage of skilled blockchain developers and consultants.	Lack of experts		
The lack of understanding or scepticism about blockchain technology could limit allocation of budgets.	Allocation of budget for new systems	Financial challenges	
There will be ongoing operational costs related to computing power, energy consumption, and network maintenance.	Finances for ongoing maintenance and upgrades		

(*Continued*)

Verbatim	First-order categories	Second-order themes	Aggregated themes
Lack of specific regulations for certain use cases can create uncertainty for education sector.	Regulatory uncertainty	Regulatory environment	Environmental Dimension
Digital Data Protection Bill. Mihaljević et al. (2023) could impact the use of blockchain for data storage and processing.			
The legal status of smart contracts executed on a blockchain is still evolving. Clear guidelines have not been established.			
Currently, no government support or policies encouraging the adoption of blockchain technology in the education sector.	Government support and policies		
New Education Policy supports establishment of Academic Bank of Credit for storing the acdemic credits earned from different educational institutions.	Academic Bank of Credit		
As of now, there is no pressure from stakeholders, such as students, parents, regulatory bodies, and accreditation agencies to adopt blockchain.	Stakeholder pressure	Stakeholders	
Educational institutions in India are not using blockchain as a way to differentiate themselves or to attract students.	Competition in market	Competitive environment	
Not many success stories from other educational institutions that have implemented blockchain, showcasing the positive impact on efficiency and security.	Lack of successful examples in India		
Educational sector in India does not rely too much on technology.	Technological maturity of education sector		

The participants of the study also explained that the higher educational institutions require to store and process large amounts of data of the existing students and the alumni. Information technology experts who were part of the study discussed the scalability issues of blockchain technology. They highlighted that the choice of the right blockchain platform and optimizing the performance will be very crucial.

> It has to be ensured that blockchain solution can handle the volume of data and transactions generated by a large institution like ours. Participant 24

The findings also reveal that the participants were not very confident about the interoperability of the blockchain technology. The contemporary blockchain platforms are subject to several limitations, the most prominent of which is the absence of interoperability among different systems (Dagher et al., 2018). The existing platforms of blockchain applications function solely within their respective networks. Despite the underlying technology being similar, it necessitates centralized third-party mediators to transfer or obtain information from other blockchain networks. The current third-party intermediaries establish trust and security by maintaining a centralized ledger to monitor "account balances" and authenticate transactions. The incapacity of autonomous blockchains to communicate with one another is an inherent issue in decentralized systems (Pillai et al., 2020).

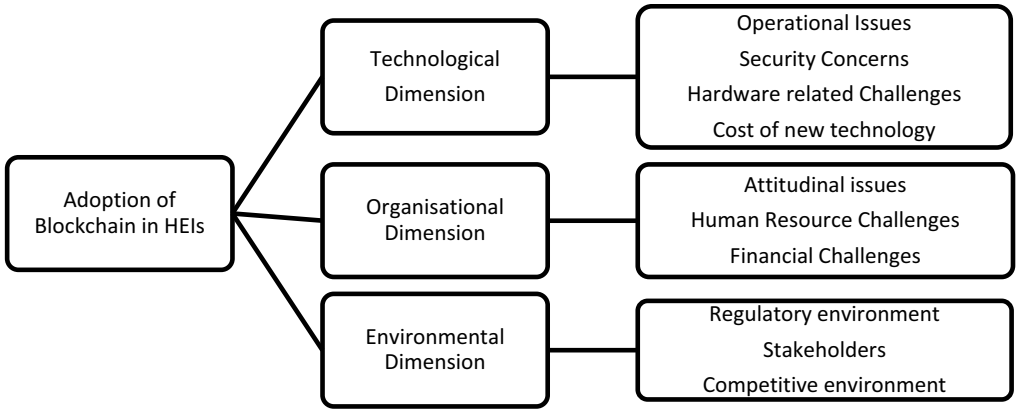

Figure 1. Conceptual framework of the study.

Source: Authors' own compilation

> There is a challenge in ensuring interoperability of blockchain technologies with old and existing systems. Participant 7

As blockchain technology becomes increasingly prevalent, the institutions adopting the technology will inevitably face challenges related to data migration. These challenges arise from a number of factors, such as moving the data from one format to another or one platform to another and the need to swap rapidly evolving blockchain engines. This process poses unique challenges, such as ensuring the reliability of data source and consistency, as well as ensuring migration efficiency (Zhang et al., 2022)

Participant 9 revealed concern about the challenge in migrating existing data to blockchain platforms.

> Migrating existing academic records and data to the blockchain securely and accurately is a complex task that would require technical expertise, a lot of careful planning and execution.

6.1.2. Security concerns

The participants of the study expressed that the adoption of blockchain technology will give rise to a multitude of apprehensions regarding security and data privacy. The interconnectivity and complexity of blockchain may elevate a range of security concerns such as hacking, cyber-attacks, and unauthorized acquisition of sensitive data. Without proper implementation, it entails the risk of unauthorized access to the students' and staff's personal information, which could be utilized for illegal purposes. Thus, participants perceive security and data privacy as a significant challenge.

> Risks and uncertainties associated with implementing blockchain, such as data privacy concerns or technical challenges may affect the adoption of technology in educational institutions. Participant 11

> I am not aware about privacy features of blockchain technology. Participant 1

> There is a potential risk due to possibility of technical glitches in the initial stages of implementation of the new technology. Participant 2

Current record management systems encounter difficulties in achieving a balance between safeguarding confidentiality of data and facilitating consistent interactions and accessibility of data to the stakeholders. Blockchain technology has emerged as a possible solution to enable data sharing in a decentralized and transactional mode. It holds great potential as it may facilitate the intricate

balance between maintaining electronic records' privacy and accessibility (Dagher et al., 2018). However, it is imperative to note that there exist cyber-attack vulnerabilities and that blockchain technology must remain vigilant in order to uphold the security of this form of digital infrastructure (Yeoh, 2017). Ramos and Queiroz (2022) in their study discovered that security and transparency are significant factors in determining trust for blockchain technology. Said factors can be utilized to forecast trust-related behaviour pertinent to the adoption of blockchain technology in developing economies. The present study found that there are obstacles that need to be overcome in terms of safeguarding information security and privacy. The findings of this study suggest that the educational institutions are not fully aware of the benefits of blockchain in maintaining data privacy and security.

6.1.3. Hardware-related challenges

The findings indicate that the limited availability and/or incompatibility of hardware and digital infrastructure may act as challenges to the successful adoption of blockchain technology by the educational institutions in India. Complementary digital infrastructure constitutes a crucial requirement for the integration of blockchain in business processes. However, educational institutions may not always have convenient access to the same. The utilization of DLT-based solutions necessitates a prior availability of broadband connection, either fixed or mobile (Gray & Gray, 2021). Additionally, the adoption of complementary technologies may also prove to be essential. The dearth of digital infrastructure, particularly in terms of high-speed broadband connection, both mobile and fixed, may pose as a significant impediment in this regard.

> Our institution's current level of technological readiness and digital infrastructure is moderate. We have taken several initiatives for academic and administrative purposes. But our systems are primarily centralised and will require upgrades to integrate blockchain in future. Participant 3

> The availability and accessibility of technological infrastructure, including high-speed internet connectivity and computing resources, will influence the feasibility of implementing blockchain solutions. Participant 20

> We do not know if it will be necessary to replace the existing infrastructure. Participant 13

India's broadband speeds, in both the mobile and fixed broadband segments, are below the global average. Reliable and high-speed internet connectivity is essential for the functioning of blockchain networks, especially for decentralized applications and real-time data synchronization. In regions with limited or inconsistent internet access, blockchain adoption may be hindered. Blockchain networks require significant computational power and storage capacity to process and store transactions (Choobineh et al., 2022). Inadequate hardware infrastructure can slow down blockchain operations.

The participants of the study also stated that the existing technology used in the educational institutions may not be compatible with the blockchain technology:

> A thorough technical evaluation will be needed to ensure that the blockchain technology aligns smoothly with the existing IT infrastructure. It might also involve potential systems upgrade or integrating blockchain as an extension to the current applications Participant 16

> The complexity of blockchain technology and its compatibility with our existing educational systems and infrastructure will impact its adoption. Participant 14

6.1.4. Cost of new technology

The implementation and post-implementation management of services for a blockchain platform requires essential capital investment by an educational institution. The availability of capital is one of the critical success factors for the adoption and implementation of blockchain technology. Depending on the need for external entities to support blockchain technology implementation, the costs can exceed the required capital investment (Zhou et al., 2020).

All the participants emphasized the importance of considering costs as a dimension in the adoption and implementation processes of blockchain technologies. This consideration involves adapting the existing infrastructure and buying new infrastructure if required:

> Our major concern is finance, as the cost of implementation of blockchain technology can be very high. Participant 16

> As a privately-run institution, you need to evaluate whether the costs align with the potential benefits. Participant 8

> Even if we are able to implement it, funding availability for technology upgrades may be limited. Participant 22

Implementing blockchain technology often requires a significant upfront investment in terms of infrastructure, hardware, software development, and skilled personnel. This initial cost can be a barrier, particularly for smaller educational institutions in India.

6.2. Organizational dimension

6.2.1. Attitudinal issues

In recent years, the higher education sector in India has witnessed the increasing adoption of new technologies. The "Digital India" initiative implemented by the Government of India is a progressive step towards promoting e-resources and strengthening digital infrastructure across the nation. This digitization endeavor presents unparalleled prospects to furnish students with superior resources while simultaneously mitigating the resource sharing discrepancies between educational institutions (Gupta & Sengupta, 2021). However, despite these efforts, there are still some institutions who are resistant to adoption of new technologies like blockchain due to barriers such as lack of resources, limited expertise, etc. The findings of the current study indicate that the organizational resistance toward adopting blockchain technology may also be a significant challenge.

> Introducing a new technology like blockchain may face resistance from faculty and staff who are not familiar with the technology. Participant 19

> Staff members and teachers may be reluctant to adapt to changes in their workflows.

> There may be initial resistance from the stakeholders unaware of the technology. Participant 10

6.2.2. Human-resource-related challenges

According to a report of the International Finance Corporation and World Bank, the factors that may exert a significant influence on the adoption of blockchain technology include the extent of advancement of the overall technological ecosystem and the accessibility of the necessary skill pool (Cao et al., 2021). The adoption of blockchain technology may take time, owing to its novelty and the limited number of individuals capable of utilizing it. Although developed nations will likely secure the most talented personnel from the global labor market, those situated in emerging economies may require more time to close the gap. In this context, one of the participants stated:

> Implementing and maintaining the blockchain solution would require a team of skilled blockchain developers, cybersecurity experts, and IT professionals who can handle ongoing maintenance, updates, and security measures. Participant 24

Presently, there exists a discrepancy between the demand for skilled workforce and the supply available. As a result, it is imperative for the institutions to provide training to their current personnel in the latest technologies. Our research indicates that the current workforce in India is not equipped with the necessary technological capabilities for blockchain. Thus, there is a pressing

need to augment the technical skillset of the existing workforce to effectively manage the deployment challenges of blockchain technology.

> We have a skilled IT team capable of handling advanced technologies, but additional training and expertise in blockchain might be necessary. Participant 11

> Training and upskilling the IT team will be essential to ensure the smooth operation of the blockchain infrastructure. Participant 14

> You will be required to conduct workshops, training sessions, and awareness programs for staff members and other people involved in the system. Participant 16

The participants also commented upon the lack of availability of skilled professionals who have an expertise in blockchain technology solutions for the education sector.

> The lack of skilled workforce is a big problem. It will be challenging for blockchain adoption in India. Participant 4

> The education system and technical training programs in India may not yet be producing an adequate number of professionals with blockchain-related skills. Participant 27

The absence of adequate digital competencies will impede implementation, particularly for small and medium-sized institutions that lack the financial resources to attract skilled personnel. Participants stated their concern about the expenses involved in hiring and skilling of human resources required for blockchain adoption.

> Training means additional cost. For the implementation of new technology, we will have to spend funds on comprehensive training sessions and workshops to educate faculty, staff, and students about blockchain technology, its advantages, and its applications in the institution. Participant 12

6.2.3. Financial challenges

For the adoption of blockchain technology the educational institutions will have to incur significant additional costs in the setup of additional infrastructure and upgrading of the existing IT infrastructure. Moreover, there is limited availability of knowledge and information about the uses of blockchain in this sector. Considering this cost burden, the educational institutions may be less interested in adopting this technology. Hence, the participants stated the financial challenges in this process:

> The lack of understanding or skepticism about blockchain technology in the education sector could limit allocation of budgets. Participant 7

> In situations of resource scarcity, it is imperative to ensure that the management is convinced to invest in the blockchain technology. This can only be achieved through two crucial factors: firstly, the advantages of the technology must be very clear, and secondly, it is vital that similar other institutions also adopt the blockchain technology. Participant 15

Participants also drew attention to the operational costs that would be involved in the usage of technology in terms of computing power required and maintenance of the network. When discussing adoption of blockchain technology, it was observed that the participants had an apprehension regarding its purportedly vast energy consumption.

> There will be ongoing operational costs related to computing power, energy consumption, and network maintenance. Participant 19

Participants also expressed their concerns about the cost of hiring skilled blockchain professionals and experts and training of the existing IT teams employed by the educational institutions.

> Hiring of skilled blockchain professionals would be costly, given the demand for experts in this field. Competition for experienced blockchain developers and specialists may also drive up salary expectations. Participant 22

6.3. Environmental dimension

6.3.1. Regulatory environment

External factors that might influence blockchain adoption in higher education in India include government regulations related to data privacy and security, funding availability and support for technology upgrades, and the overall technological maturity of the education sector in India. In order to fully utilize the benefits of blockchain for emerging market economies like India, it is essential to establish a regulatory environment that will foster competition and investment while also promoting innovation. However, at present, there are no specific laws to regulate blockchain technology in India. As specified by the participants:

> Lack of specific regulations for certain use cases can create uncertainty for education sector

> The legal status of smart contracts executed on a blockchain is still evolving. Indian government has not established any clear guidelines.

Participants also opined that, in the absence of governmental support or policies for adoption of blockchain technology in the education sector, the higher educational institutions may be unwilling or not motivated for the same.

> Currently there is no government support or policies encouraging the adoption of blockchain technology in the education sector.

The legal and regulatory landscape for educational data management and privacy will shape the feasibility of blockchain adoption. The Digital Data Protection Bill 2023 is currently under discussion in the Indian Parliament. This legislation is designated to facilitate the handling of electronic personal data in a manner that acknowledges the right of persons to safeguard their personal data whilst recognizing the necessity of processing such data for legitimate purposes and for ancillary or connected matters. One of the participants, aware of this regulatory development stated:

> Digital Data Protection Bill 2023 could impact the use of blockchain for data storage and processing.

It was found that institutions are deeply concerned with regard to data security and the escalating expenses associated with data breaches. It is of utmost importance to establish clear business regulations for data governance, storage, transmission, and utilization. However, higher education institutions are facing greater challenges in devising and upholding these regulations due to the rapid pace of digital transformation.

6.3.2. Stakeholders

Despite the presence of a multitude of stakeholders in the education ecosystem, such as students, parents, teachers, administrators, and private/public service providers, they continue to encounter several obstacles related to the accessibility of information, obsolete and difficult procedures for providing information, maintaining consistency in learning, preserving, and distributing learning records, and sharing credits and credentials in an effortless and effective manner (Hoel & Chen, 2016). In this scenario, pressures from stakeholders, such as students, parents, regulatory bodies, and accreditation agencies, can drive institutions to adopt blockchain for enhanced transparency

and accountability. But as stated by participants, they did not experience any such pressure from their stakeholders.

> According to my knowledge, the adoption of blockchain technology in the education sector in India is still in its very early stages

> As of now there is no pressure from stakeholders, such as students, parents, regulatory bodies, and accreditation agencies to adopt blockchain.

Although there is currently no pressure from the stakeholders to adopt blockchain, the experts in the educational sector are aware that the demand for adoption of blockchain may arise in the near future. One of the participants involved in the higher management team of a university responded:

> Students who go abroad for education may face challenges in getting their qualifications recognized. Blockchain-based records can provide international recognition and ease the process of transferring credits between institutions.

Few participants also agreed that blockchain technology may have a lot of benefit for the educational institutions for gaining trust of their stakeholders and stated:

> Adopting blockchain can show our institution's commitment to transparency and accountability which can help in building trust among stakeholders. It may also lead to a positive reputation.

6.3.3. Competitive environment

In the competitive landscape within the education sector, the introduction of blockchain technology by some institutions could potentially exert significant pressure on other market players to adopt it as well. Educational institutions might adopt blockchain as a way to differentiate themselves and attract students.

> In a competitive scenario, if any of our competitors adopts blockchain, then we might also be under a pressure to do the same.

> Educational institutions, here in India are not using blockchain as a way to differentiate themselves or to attract students.

A significant portion of the utilization of blockchain technology that has been reported globally is, nonetheless, still confined to Blockchain technologies 1.0 and 2.0. For instance, UNICEF's Project Connect is presently overseeing a multitude of blockchain-mediated educational initiatives. These initiatives encompass the dissemination of open-source technologies among developing communities, investment in educational projects, institutional funding, charity grants, and crowdfunding (Cacioli, 2020). Across all of these applications, the foremost advantage is that records concerning accounting, investments, and donations to education are impervious to tampering or control by any single authority. However, there is a dearth of such blockchain use cases in India. One of the participants stated:

> I am not aware of any successful examples from other educational institutions that have implemented blockchain, which can showcase the positive impact on efficiency in academic administration or data security.

6.4. Discussion of findings

The above findings provide a comprehensive understanding of the challenges hindering blockchain adoption in higher education in India. Policymakers and administrators can use this knowledge to create tailored strategies, policies, and initiatives that foster successful integration of blockchain technology, ultimately enhancing the quality and relevance of education in the digital age. The challenges categorized under the TOE (Technology, Organization, and Environment) framework

can provide valuable insights and recommendations for decision-makers in academia. It can serve as a foundation for policymakers to devise strategies and policies aimed at fostering blockchain adoption in higher education. It can provide a roadmap for drafting policies that address challenges related to technology integration, organizational readiness, and the environmental factors influencing adoption. Understanding the challenges identified in this research paper can guide administrators in allocating resources effectively. This might include budgeting for technology infrastructure upgrades, training programs for staff and faculty, and fostering a culture that encourages experimentation and innovation.

There can be several institutional strategies for technology adoption which could enhance the applicability of research findings. Institutions should prioritize investing in robust and adaptable technological infrastructure capable of supporting blockchain implementations. This includes upgrading network systems, security protocols, and computing resources to facilitate the integration of blockchain technology. Institutions can initiate pilot projects based on the identified challenges and proposed solutions. These projects can serve as case studies, providing practical examples of successful implementations and serving as learning models for others. Another crucial strategy can be stakeholder engagement and communication with students, faculty, administrative staff, and external partners, in discussions about blockchain adoption. Transparent communication about the benefits, challenges, and potential impact of blockchain technology can garner support and encourage involvement. It also requires collaboration and knowledge-sharing initiatives with other educational institutions, both nationally and internationally, to exchange experiences, best practices, and lessons learned in blockchain adoption. Regulators will have to establish clear policies and governance frameworks addressing data privacy, security, and ethical considerations specific to blockchain technology. By incorporating these institutional strategies, higher education institutions in India can effectively address the challenges and pave the way for successful blockchain adoption in their academic environments.

7. Implications

The utilization of blockchain technology is presently in its nascent stage within the educational sector in India. Different companies and start-ups might be developing blockchain-based solutions for education. These could include technology firms specializing in blockchain, Edutech start-ups, and even established educational institutions exploring their own solutions. The findings indicate that blockchain technology is perceived as a complex technology. Educational institutions are resistant to adoption of new technologies like blockchain due to barriers such as lack of financial resources, shortage of human resources, limited expertise, lack of specific regulations, etc. The findings of the current study indicate that the organizational resistance toward adopting blockchain technology may also be a significant challenge. Blockchain technology thereby engenders criticisms regarding certain facets of its adoption. Alammary et al. (2019) identified various challenges that impede the incorporation and execution of blockchain technology in education, encompassing apprehensions regarding malicious attacks, divulgence of data, and dearth of confidence in data sharing.

The study has implications for the regulating agencies and policy-makers in the education sector of India. Blockchain technology has the potential to revolutionize various aspects of education, such as credential verification, secure storage of student records, reducing fraudulent activities, and facilitating efficient administrative processes (Ramos & Queiroz, 2022). In order to fully utilize the benefits of blockchain for emerging market economies like India, it is essential for the government to establish a regulatory environment that will foster competition and investment while also promoting innovation. This requires collaboration between regulators and businesses, in order to create a governance framework that enables experimentation and learning. By doing so, they can shape the future of the technology in a manner that benefits all involved parties, as well as society as a whole. The regulatory environment and compliance standards would play a role in shaping how blockchain solutions are adopted in the education sector. This includes data privacy laws and other relevant regulations. Accreditation agencies need to ensure that institutions meet

specific educational standards. Blockchain can create an immutable record of academic history, making it easier for accreditation agencies to verify compliance and quality.

The findings of this paper also have practical implications for the educational institutions. The findings show that the level of awareness and understanding of blockchain technology among educational institutions, administrators, and students can impact its adoption. Educational institutions that can effectively educate stakeholders on the benefits and use cases of blockchain in education might have a competitive advantage. Institutions can use the findings to seek collaborations with industry experts, tech companies, and other educational institutions experienced in blockchain technology. Collaborative initiatives can facilitate knowledge sharing, joint research projects, and pilot programs that address the identified challenges. Implementing new technology often requires changes in organizational culture and processes. The findings of this paper can assist administrators in developing change management strategies that address resistance to change, ensuring smoother integration of blockchain technology.

8. Conclusion

Blockchain technology has the potential to be highly advantageous in emerging markets. However, it is important to note that the technology is still in its early stages of development. As such, it must overcome a multitude of serious challenges and risks, both technical and regulatory, before it can be widely adopted. The study found 10 main challenges that were categorized under the three dimensions of the TOE framework. Challenges under the technological dimension include operational issues, security concerns, hardware-related issues, and cost of new technology. Organizational dimension includes attitudinal issues, human-resource-related challenges, and financial challenges. The third dimension, i.e. environmental dimension, covered the challenges relating to regulatory environment, stakeholders, and the competitive environment.

The study suggests that educating key stakeholders, both in the private and public sectors, about the technology's benefits remains a big challenge. However, HEIs cannot afford to ignore this new technological development and have to be prepared for its adoption. HEIs also need to weigh the challenges in adopting the blockchain technology against the numerous benefits it has to offer. A closer look at the challenges involved in adoption might provide a better opportunity for overcoming these challenges.

9. Limitations of the study and future research

This study exhibits certain limitations that could be addressed in forthcoming research. Firstly, the analysis has solely focused on the outlooks of higher administration teams and IT teams in private universities. Although the findings extend to Blockchain in general, they may not include the relevant inputs from state or government-owned institutes or universities. Future inquiries may take into consideration the perceptions of participants from government bodies and state-owned universities, as well as from faculty members and students to obtain a comprehensive understanding of the impediments to blockchain adoption in the education sector. Secondly, the research sample was concentrated solely on one region in India, thereby lacking generalizability to other countries. Research in other emerging economies might be needed to authenticate the conclusions of the present study. In addition, this study has employed a qualitative methodology using semi-structured interviews. Future studies may employ empirical techniques or mixed-methods research to test the suggested model.

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