Blockchain in education: the influence of trust on adoption and implementation

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Abstract

Purpose – This paper aims to investigate the influence of trust on adopting and implementing blockchain technology in higher education institutions (HEIs) in Brazil.

Design/methodology/approach – This study uses an exploratory qualitative approach to understand the construct of trust in the context of the educational sector. Data were collected through semistructured questionnaires and online interviews.

Findings – The research identified that, for most potential blockchain users, trust positively influences the HEIs, because benefits such as secure data sharing and transaction transparency could optimize the daily routine and avoid fraud in academic documents, providing a cooperative and reliable working environment. In addition, the results suggest that trust is needed to overcome challenges related to issues such as costs and privacy.

Research limitations/implications – This study contributes to the advances in the emerging literature on blockchain in the educational sector as a system with the potential to generate trust, as well as the literature on the technology acceptance models.

Practical implications – For HEI managers and practitioners, this study highlights the need for a greater understanding of the influence of trust in the relationships between HEIs and other stakeholders.

Social implications – This work shows that adopting blockchain technologies would allow users to build social relationships of trust in a cooperative work environment and develop trusted behavior by sharing data securely and transparently.

Originality/value – To the best of the authors' knowledge, this is one of the first studies on the adoption and implementation of blockchain in the education sector in Brazil.

Keywords Trust, Higher education, Adoption, Blockchain

Paper type Research paper

1. Introduction

Recently, traditional sectors of the economy (e.g. retail, transport, manufacturing, services and health care) have been impacted due to the rapid advancement of information and

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communication technologies (Queiroz et al., 2021; Wendland et al., 2019; Schuetz & Venkatesh, 2020). Consequently, organizations are challenged to rethink their business models, seeking to adapt and support technological innovations, mainly due to advances in digital transformation (Gong & Ribiere, 2021). In this context, blockchain, which is considered a disruptive technology, has advanced in several sectors. Blockchain can be defined as a digital ledger with a high level of cryptography stored on several computers in a network that comprises blocks of interconnected information, which cannot be changed or deleted after its validation (Wang et al., 2017; Toufaily et al., 2021). In other words, blockchain allows, through advanced cryptography, the sharing of this data in a reliable, secure and immutable way (Iansiti & Lakhani, 2017). Furthermore, all transactions are communicated to all network agents (nodes), and the information contained in the blocks can be validated by consensus of the network participants to preserve the security of the transactions (Queiroz & Wamba, 2019).

The existing literature on the blockchain has increased significantly because its introduction in the financial sector (Nakamoto, 2008). Moreover, over a few years, blockchain technologies joined the agenda of organizations from various sectors (Tapscott & Tapscott, 2017). Consequently, blockchain adoption emerged as a robust research stream in the past few years (Wamba & Queiroz, 2022; Wong et al., 2020). However, despite the recent progress in the blockchain adoption literature (Angelis & Ribeiro da Silva, 2019; Janssen et al., 2020), it is still in the infancy stage in the education segment (Alammary et al., 2019; Han et al., 2018).

Besides, trust seems to be a critical aspect and a not fully explored construct (Wan et al., 2022; Völter et al., 2021; Niu et al., 2021), mainly in blockchain education (Alammary et al., 2019). Some research has explored the role of trust in the blockchain adoption context (de Filippi et al., 2020). For instance, Wan et al. (2022) found that blockchain improves the positive impact of social trust in contexts related to collaborative innovation. Shao et al. (2022) explored blockchain trust in the healthcare sector. They reported that trust does not directly influence other members to use a blockchain-enabled platform. In that vein, exploring the influence of trust in blockchain adoption by the Brazilian higher education institutions (HEIs) can contribute simultaneously to enriching the literature and unlocking practical insights for decision-makers in related fields.

Furthermore, in Brazil, the Ministry of Education (MEC) has adopted measures toward the modernization of processes in education since, in educational institutions, there is information that can be lost or falsified, which is currently one of the biggest problems faced by the federal government, concerning the issuance and validation of student documentation. To solve this problem, MEC published Ordinance No. 554/2019, which regulates a mandatory digital certification of documents issued by HEIs throughout the country (BRASIL, 2019).

Thus, this study focuses on blockchain applications considering mainly its potential to store and share reliable data, which includes several types of academic records. In an attempt to minimize this gap, we sought to identify the influence of trust in the adoption and implementation of blockchain by the Brazilian HEI sector, supported by the emerging literature on blockchain and with the theoretical framework of the technology acceptance model (TAM). Given this scenario, the following research question (*RQ*) arises:

RQ: How does trust influence the adoption and implementation of blockchain by Brazilian HEIs?

2. Theoretical background

2.1 Blockchain and its features

Blockchain can be defined as a digital book with encryption, stored on several computers in a public or private network, comprising data records or blocks (Wang et al., 2017; Queiroz & Fosso Wamba, 2019). Thus, each transaction is placed in a block, and each block is linked to the one before and after it, in an irreversible chain, in which transactions are blocked together; hence, the term *blockchain* (Wang et al., 2017; Queiroz & Fosso Wamba, 2019). Once these blocks are collected in a chain, they cannot be changed or deleted. Besides, they are verified and managed using government protocols. In other words, blockchain technology is a structure that contains data recording blocks stored on distributed nodes. Nodes are services using blockchains situated in some communication networks, using a shared communication protocol (Viriyasitavat et al., 2020).

Regarding the accessibility of the network, there are two blockchain modes. For instance, there is no need for permission to join the network in the permissionless blockchain mode. It refers to public blockchains (Helliar et al., 2020; Toufaily et al., 2021). This mode permits users to join the mining process to validate transactions. Bitcoin is a classic example of permissionless blockchains (Helliar et al., 2020; Toufaily et al., 2021). On the other hand, the permissioned blockchain mode requires authorization (permission) to participate in the network. This type of blockchain is also known as *private blockchain*. An example of organizations that use this mode are banks (Helliar et al., 2020; Toufaily et al., 2021). It is important to note that both approaches (public and private) operate with a P2P network and timestamping of transactions (Toufaily et al., 2021).

2.2 Blockchain applied in the educational field

A significant part of educational institutions currently uses an obsolete and inadequate way to manage and authenticate student records and credentials (Han et al., 2018; Liu et al., 2018). Upon request, these credentials and transcripts are delivered in print, in sealed envelopes, directly to the interested parties. Any photocopies or unsealed records that students keep in their possession are considered unofficial and do not have the same legal significance during the hiring or recruitment process. Verification of these documents is usually obtained by asking the issuing authority that needs to maintain a long-term file (Grech & Camilleri, 2017).

This system, that is, the institution as the sole authority and holder of students' learning credentials and records, makes it inefficient for any employer or interested third party to verify the authenticity of students' learning records and credentials, particularly when the student has attended different institutions. This centralization wastes time and money for institutions, students and employers. Furthermore, especially in the 21st century and in the age of digital transformation, this process seems even more outdated and inadequate (Han et al., 2018; Liu et al., 2018).

In addition, in the generation of the certificates, blockchain would provide the certificates in blocks without third-party intermediation, ensuring security to avoid false certificates. Moreover, it could provide secure access to participants, storing all certification identities and the whole process could be monitored by the supporting management of certification authorities and smart contracts. At the same time, blockchain could show anyone, anywhere, that the student has a diploma registered and validated in an integral and immutable way (Ahrendt, Pace, & Schneider, 2018).

Alammary et al. (2019) highlight the main benefits that blockchain could bring to the education field:

- security, concerning data protection, privacy and integrity;
- better control over who and how student data is accessed;
- increased accountability and transparency;
- increasing trust between all parties included and facilitating communication between them;
- reduction of costs associated with transactions and data storage;
- authentication of students' identities and their digital certificates;
- improvement in the way learning outcomes and student performance are evaluated;
- improved efficiency of exchange data and student record management;
- improvement of student interactivity, blockchain system interoperability; and
- support for students' career decisions.

2.3 Technology acceptance theories

The literature on TAMs has grown significantly through the years (Fishbein & Ajzen, 1975; Davis, 1989; Venkatesh et al., 2003). In this sense, some theories have stood out, such as the TAM proposed by Davis (1989), which aims to understand individual behaviors in the acceptance and adoption of information technologies (IT). The unified theory of acceptance and use of technology (UTAUT) was proposed by Venkatesh et al. (2003) to synthesize the main models previously reported in the literature, showing that the user expects to achieve some benefits related to performance improvement and effort minimization when adopting a given technology. In addition, aspects related to the facilitating organization conditions and the peer influence also affect this adoption. Besides, trust has received considerable attention from authors who adapted these previous technology acceptance theories (Gefen et al., 2003; Gefen et al., 2011).

3. Methodology

The present study uses a qualitative approach, seeking to assess how trust influences the adoption and implementation of blockchain technology, considering HEIs in Brazil. Qualitative research makes it possible to understand the trust construct in the context of the Brazilian educational sector, analyzing it from an integrated perspective. The research method used was a single case study with multiple units of analysis (Yin, 2014). This work can be considered inductive research with exploratory data analysis (Jussani et al., 2018; Jebb et al., 2017), i.e. the influence of trust on the adoption and implementation of blockchain technology. Considering the nascent literature about blockchain in the education sector (Alammary et al., 2019; Han et al., 2018), we have chosen HEIs that operate in a representative market. Thus, the unity of analysis was Brazilian private and public HEIs.

Primary data collection was carried out through a semistructured questionnaire with open questions (Ralph et al., 2020), made available through the online platform Google Forms, from October 15, 2020 to December 15, 2020. The questionnaire was addressed to a sample of directors, coordinators, administrative technicians and professors from public and private HEIs. The survey link was sent via e-mail and WhatsApp to 70 people previously selected according to their position at the HEI, obtaining a return of 30 responses considered valid. Before distributing the questionnaire, a pretest was carried out with four respondents, two university professors and two IT professionals who are currently working in educational institutions, to reduce the inaccuracy of the questionnaire and confirm the validity of the content.

Regarding validity, this research is characterized by internal validity, following the main recommendations and best practices, such as triangulation of data from various sources (questionnaire and interviews), verification of respondents, peer review and participants involved throughout various phases of the study (Rashid et al., 2019; Creswell, 2007). In this sense, we categorized the results by using a content analysis approach (Schiavi et al., 2019). Based on the existing literature, we identified key categories (considering their frequency and relevance), which, in turn, were used to support the analysis of the questionnaire and interviews. We used an Excel spreadsheet to give support to the categorization. In addition, we compared the literature with empirical pieces of evidence (Corrêa et al., 2022).

Additionally, in-depth semistructured interviews (Stieglitz et al., 2022) were carried out with five senior professionals (professors and IT practitioners) with prior knowledge of blockchain due to the need to obtain a sample from people who are effectively close to the topic not to compromise the reliability of this research. The sessions lasted around 50 min per person, on a voluntary and confidential basis, to capture respondents' different views regarding blockchain adoption and implementation. Collected data were transcribed, and transcripts were coded using Excel analysis.

4. Analysis and discussion of results

4.1 Higher education institution representatives' data analysis

Data collection was carried out through a questionnaire, which obtained a total of 30 respondents from public and private HEIs, referred to as respondents 1 to 30 or R1 to R30.

Five interviews were also carried out with professors who are researchers of blockchain technology and professionals in the field of IT who have practical knowledge of blockchain. The participants of this research work in different sectors of educational institutions, which makes it possible to obtain a more comprehensive view of the influence of trust in this sector.

The profile of the questionnaire respondents shows that they work in different fields of education. For example, directors were the position with the most respondents (10), followed by coordinators (9), professors (8), IT analyst (1), administrative technician (1) and administration assistant (1).

The choice of HEI representatives was made according to their position, prioritizing those who have greater decision-making power in case of innovation processes to be adopted and implemented by the institution.

Table 1 shows that the dimensions most cited by respondents are related to security, management, storage and sharing of documents, trust and transparency as positive factors associated with blockchain. Thus, to provide an in-depth connection with the literature, we highlight some key quotes.

For instance, R13 shows an optimistic view of trust in a system considered safe:

> "In theory, trust should improve, as electronic transactions at the institution will be faster and more reliable. The knowledge acquired can also be shared, as it opens up a space for digitizing and archiving physical (paper) documents."

According to R23, the possibility of implementing an innovative system (blockchain) ". . .is very beneficial as it avoids the possibility of fraud. Security and transparency are paramount to a credible and fair administration."

R27 lists secure data sharing through blockchain as a dimension that increases trust and can add value:

Table 1.
Main topics of the questionnaire that emerged from the literature

Questions	Costs (Blockchain literature)	Agility (Blockchain literature)	Information security (Blockchain literature)	Document management, storage and sharing (Blockchain literature)	Transparency (Blockchain literature)	Cooperation Blockchain literature)	Trust (TAM literature)	Network (Blockchain literature)
1. How do you see the possibility of using an innovative system (blockchain) that is considered transparent, tamper-proof, and that can allow secure data sharing without intermediaries, thus offering equal access and opportunities to all higher education institutions (HEI)?			R5, R23	R13, R15	R23			
2. How does your institution see the possibility of adopting and implementing a system (blockchain) that is considered fail-safe and could securely store different types of student documents?					R8			
3. Talk about how your HEI understands the possibility of using a system (blockchain) that can save time and effort in carrying out daily tasks.		R10						
4. Comment on how your HEI understands the possibility of investing financial resources in adopting and implementing innovative technology, replacing the existing IT infrastructure and optimizing the performance of daily tasks.	R28	R27, R28	R27					

(*continued*)

Table 1.

Questions	Costs (Blockchain literature)	Agility (Blockchain literature)	Information security (Blockchain literature)	Document management, storage and sharing (Blockchain literature)	Transparency (Blockchain literature)	Cooperation Blockchain literature)	Trust (TAM literature)	Network (Blockchain literature)
5. Comment on how your institution understands the possibility of issuing and storing documents through a system (blockchain) that is considered secure and immutable.	R28	R9			R27			
6. Explain whether sharing data between HEIs through innovative technology (blockchain) can influence the relationships between HEI agents. For example, improving or worsening trust, cooperation, knowledge exchange, etc.	R27		R14	R5, R13, R18, R20, R23		R1, R10, R18, R23, R27	R7, R13, R18, R22, R27	R17, R20
7. Tell us how your institution understands the possibility of a system (blockchain) allowing you to monitor the evolution of the academic life of students.	R7		R7		R5		R5, R23	
8. Comment if your institution is comfortable sharing data with suppliers through a system (blockchain) that can promote the sharing of documents and information among all network participants.			R2, R13		R10, R17	R28		R21, R25, R28

> "Sharing data securely always increases trust – the same with cooperation and knowledge exchange. Innovation for innovation's sake does not add value. Innovative technology must necessarily add value to the university's business, as in any other corporate organization."

For R23, sharing data through blockchain technology is related to the exchange of experiences that are important for the growth of cooperation between HEIs:

> "Sharing data between HEIs would help standardize procedures performed at HEIs, bring greater cooperation between units, and provide an exchange of information."

Through the answers obtained in the questionnaire, the existence of trust can be verified, as well as the expectation that, with the new technology, mechanisms such as cooperation and information sharing between educational institutions will become part of the HEIs members' routine.

Assuming that there is trust in the blockchain, as reported in the existing literature, we sought to analyze whether it could influence the decision to adopt and implement the blockchain. R9 states that trust must exist between network members, both inside and outside the educational institution:

> "I believe that in this case, the institution will depend on the reliability that the system supplier will offer it (the institution). In this case, it will depend much more on the seriousness of the supplier than on the institution itself."

R19 revealed concern about the possible misuse of information inserted in this new technology:

> "Many civil servants, in my opinion, will feel insecure since we have witnessed constant cases of misuse of information caused by the fragility of some innovative technologies."

However, R17 states that confidence in the new technology would come with the decision of more and more institutions to adopt and implement blockchain:

> "There is a phenomenon in the adoption of innovations that is called the network effect. As there are still few adopters, today (trust) would not have a direct influence. But certainly, as more organizations start using it, it will be a positive point."

It is worth mentioning that the variable costs appear among the least mentioned. A possible explanation for this result could be what R28 states:

> "It would not necessarily be necessary to replace existing infrastructure, at least not all the equipment."

In turn, R29 associates the costs with the benefits and engagement of the HEIs as essential factors for the decision to adopt and implement the blockchain:

> "In times of resource contingency, for there to be any possibility of convincing the high administration, two things must occur: the benefits must be very evident, and other similar institutions should also join the blockchain."

Considering the respondents' reports, we can see that blockchain can strengthen trust by enabling the exchange of information between members who work in an educational institution and between the HEIs themselves. In addition, it is perceived that cooperation and knowledge exchange can generate a reliable environment.

For R5:

> "Sharing data between HEIs (through blockchain) can (positively) influence the relationships between people working in HEIs. Relationships would be more cooperative, and there would be a lot of knowledge exchange."

R13 reinforces the idea of collaborative and trusting behavior:

> "The exchange (and collaborative construction) of knowledge can also be positively influenced as an innovative technology opens up several opportunities for teaching and research, expanding the institution's horizons."

The cooperation and network dimensions appear next, demonstrating that an innovation process cannot be carried out reliably and efficiently without the active and reciprocal participation of all those involved. Some respondents described the relationship between these dimensions associated with the possible benefits to be achieved by the HEIs when adopting and implementing the blockchain in the HEIs where they work. For example, for R28:

> "Working in a network, collaboratively, promoting partnerships, can offer benefits to all users in terms of research funding, collaboration between researchers, and efficiency in data collection by the State to revalidate courses, among other aspects."

In this scenario, given the benefits that could derive from trustful relationships between members, we observe that trust can positively influence the decision to adopt and implement the blockchain.

4.2 Researchers and information technology professionals' data analysis

The findings of the interviews with researchers and IT professionals complement the previous results. For instance, for interviewee 1 (I1), a professor who coordinates a group of researchers that implemented blockchain technology for the issuance of academic certificates in a pioneer university in Brazil, trust is related to the successful use of this technology in other sectors:

> 'To check the level of trust, just go to the sites that list the value of cryptocurrencies and see how much people trust it. If a person is willing to pay 250,000 for a bitcoin, it is because they trust the technology a lot."

The report by I4, a professor and professional in network infrastructure, demonstrates that trust must be present not only in the functioning of the technology but also in the relationships and interactions among the network members who will use the system. Moreover, the disintermediation and the possibility of verifying the data inserted into the blockchain by any individual can bring confidence in transactions:

> "The miner is usually going to validate this, so if you don't have trusted people at the top of the network of those who are validating, data can be inserted and break this chain. Anyone has to be able to verify the certificates; that's where you bring confidence."

As well as trust, costs were mentioned by all interviewees as a dimension that should be considered in the adoption and implementation processes of new technologies, as it requires adapting the existing infrastructure, training professionals, as well as other actions. Concerning infrastructure, I2 says that:

> "If it is a public blockchain, the immutability is greater because it will be in a gigantic public cloud; if it is in a private one, it depends on a server; its own server depends on an IT infrastructure."

Reinforcing this statement, I4 says:

> "You will need physical resources, machines, computers. You have to have a whole infrastructure to do that."

Another cost-related issue is the increase in energy consumption. According to I4:

> "It's the computer being on longer (and) taking longer to process. Spending energy just to get a stamp of approval does not have much validity, so it has to be a network of universities, several managing to stamp it, which is mining."

However, for I5, a researcher and professor, the increase in energy consumption can be afforded using the natural resources available on the planet:

"Energy is an issue directly linked to our issue of sustainability within the planet. I believe that we will find solutions in the medium term, five years, at most ten years. I believe that we will find solutions for this and make energy available on the planet to handle this."

In contrast to reports claiming that costs can impede blockchain adoption, I1 argues, referring to the high cost of fraud involving academic certificates, that:

> "The cost of registering on the blockchain is very low compared to the manual validation process and the fraud that happens because people do not do this manual process."

I5 corroborates this opinion, relating the cost to the necessity to meet the institution's needs:

> "Talking about value, it comes precisely by increasing the benefit, satisfying a greater number of needs and reducing the cost, not only what you pay, but the psychological effort, the effort in terms of time, the strain to achieve (security)."

I5 broadens the reflection to a business vision, in which the cost-benefit compensates for the financial investment:

> "Whoever has this strategic vision and makes a cost-benefit ratio of scope, objectives, and risks will continue to invest because, without a doubt, blockchain technology will handle this and achieve a great disintermediation effort."

Respondents drew attention to the training of IT professionals, an essential category for the excellent development of blockchain technology in education. In the opinion of I4:

> "It needs trained people to handle it well. The cost of skilled people to operate this, that's the biggest problem, because it's a very new technology, I don't see general knowledge for an IT person to operate the blockchain."

I2, professor and IT professional, states that:

> "The shortage of professionals in the IT field is a problem and gets even worse when it comes to professionals who know how to work with blockchain. There are really very few."

For I1, IT professionals will be responsible for testing and validating how blockchain technology works:

> "We are going to have something mature, validated, because, in Brazil, some of the best information technology professionals and information security professionals work in these universities so that the blockchain will go through a very strong and very rigorous validation process."

Table 2 synthesizes the interviewed professionals' reported findings concerning technology adoption and implementation in education.

5. Implications

5.1 Theoretical implications

This study found that trust is present in the relationship of potential HEI users of blockchain because the security and transparency offered by this technology would

Topic	Interviewee 1 (Professor and Coordinator) I1	Interviewee 2 (Professor and IT professional) I2	Interviewee 3 (Professor and IT Researcher) I3	Interviewee 4 (Professor and network infrastructure professional) I4	Interviewee 5 (Professor and Researcher) I5
Confidentiality		X			X
Information security	X	X		X	X
Costs	X	X	X	X	X
Fraud	X	X		X	X
Legislation (MEC)	X	X			
Validation	X			X	
Digital signature	X	X		X	
Transparency	X				X
Immutability	X	X		X	
Disintermediation	X				X
Trust	X	X	X	X	X
Decentralization	X			X	
Technological paradigm change	X				
Saving time and effort	X	X		X	X
System/ infrastructure adaptation	X	X		X	
IT professionals	X	X	X	X	
Privacy	X				X
Performance/ speed	X	X			
Research investment	X				X
Energy consumption	X			X	X
Mining time				X	X
Consensus	X	X	X	X	
Purpose of use		X	X		
Benefits	X	X	X	X	X
Authenticity		X	X		
Complexity		X	X		X
Veracity			X		
Bureaucracy	X			X	
Traceability				X	X
Innovation				X	X
Training			X	X	
Business processes		X	X		

Table 2.
Summary of the findings from interviews

influence the relationship both in the work environment of a specific institution and among Brazilian HEIs through cooperative behavior, in which the exchange of knowledge could bring benefits to all those involved in the network. However, the implementation of blockchain technology is still in an early exploratory period in the educational sector, which generates criticism about some points of blockchain implementation. Scholars such as

Alammary et al. (2019) point out challenges in adopting and implementing blockchain technology in education, such as concerns about malicious attacks, data leakage and lack of trust in data sharing.

Our results contribute to the debate and the advance of literature on TAMs, which explores trust (Gefen et al., 2003, 2011) and related constructs, such as social influence (Venkatesh et al., 2003). Besides, it brings new implications to the blockchain literature applied to the educational sector (Alammary et al., 2019). For example, we found that security and transparency are key variables related to trust. In other words, these variables can be used to predict the behavior of trust towards blockchain adoption in emerging economies. Moreover, while recent literature found that trust in members does not directly influence others to use a blockchain-enabled platform (Shao et al., 2022), our results suggest that blockchain can influence the relationships in the work environment of the same institution and other institutions of Brazilian higher education through trust and cooperative behavior.

5.2 Managerial implications

It is noteworthy that trust in blockchain technology has been widespread in several segments, and although it is not yet recognized in the Brazilian educational sector, it is possible to notice the interest of MEC and managers of educational institutions in the modernization of their processes through digital technology (Brasil, 2019). In this sense, blockchain technology meets the requirements of MEC by offering certification and digital preservation tools and being able to be monitored by the supporting management of certification authorities and smart contracts (Ahrendt, Pace, & Schneider, 2018).

Our findings can contribute to managers and practitioners in Brazilian HEIs interested in starting blockchain projects in their institutions because the awareness of trust in the technology as well as in the members of this sector plays an essential role in blockchain adoption. Therefore, practitioners should pay attention to trust and other related variables such as security and transparency.

5.3 Social implications

This study brings out some social implications. For instance, the implementation of new technology impacts the relationships of trust between the members within the spaces that use it. In this sense, when analyzing the adoption and implementation of blockchain in the educational sector, this work identified that such a decision would allow users to build social relationships of trust in a cooperative work environment, as well as to develop trusted behaviors when sharing data with security and transparency. Furthermore, according to Gössling (2004), trust is more likely to occur and predominate when actors interact personally and directly in the same work environment. Therefore, trust is not introduced in an imposing way in relationships but rather emerges as a positive response to social interactions and standardized procedures that characterize them.

6. Final considerations

Our study identified that trusty relationships are influenced by the potential benefits that the adoption and implementation of blockchain can generate, such as the possibility of avoiding fraud in the issuance and certification of academic documents, security in the exchange of information, traceability, standardization of daily tasks, construction of a collaborative environment and cost reduction. As to the latter, in the sense of reducing time and effort in performing daily tasks, and eliminating expenses with document storage; thus, satisfying the interests of HEIs and adding value and credibility to the institutions.

We also found that there are challenges to be overcome concerning information security and privacy. In this sense, the practical applications of blockchain have shown that its immutability and consensus verification characteristics have been efficient in guaranteeing the security and preservation of the data chain. Regarding privacy, it is noted that several technological resources already implemented require the insertion of personal or legal data to carry out the desired transactions; that is, it is accepted to give up a certain level of privacy to have the personal needs and interests of the institutions taken care of, as measures that add value and even survival.

Regarding the challenges, some respondents are concerned about costs, as there are HEIs that would not be able to implement technology such as blockchain without the federal government's financial support. In addition, a barrier found by this research was the limitation of the literature, as it is still an emerging topic. Another obstacle was the impossibility of conducting face-to-face interviews due to the COVID-19 pandemic and visiting institutions that implemented the blockchain and underwent changes in their infrastructure, work processes and interpersonal relationships to adopt this new technology.

In terms of future research, we suggest researchers assess whether the interest in adopting and implementing an innovative technology such as blockchain comes only from large institutions, due to the number of students attended and processes carried out, with physical and financial resources to do so or if the desire for innovative technology is a trend that affects the educational sector as a whole.

References

Ahrendt, W., Pace, G. J., & Schneider, G. (2018). Smart contracts: A killer application for deductive source code verification. In P. Müller, & I. Schaefer (Eds.), *Principled software development*, *Cham*: *Springer*, doi: https://doi.org/10.1007/978-3-319-98047-8_1.

Alammary, A., Alhazmi, S., Almasri, M., & Gillani, S. (2019). Blockchain-based applications in education: A systematic review. *Applied Sciences*, *9*(12), 2400, doi: https://doi.org/10.3390/app9122400. MDPI AG.

Angelis, J., & Ribeiro da Silva, E. (2019). Blockchain adoption: A value driver perspective. *Business Horizons*, *62*(3), 307–314, doi: https://doi.org/10.1016/j.bushor.2018.12.001.

Brasil. (2019). Dispõe sobre a emissão e o registro de diploma de graduação, por meio digital, pelas instituições de ensino Superior – IES pertencentes ao sistema federal de ensino. Diário Oficial da União, ano 12/03/2019, n. 48, p. 23 e 24. Portaria MEC n. 554, de 11 de março de 2019. Retrieved from www.semesp.org.br/wp-content/uploads/2019/03/PORTARIA-MEC-N%C2%BA-554-DE-11-DE-MAR%C3%87O-DE-2019.pdf

Corrêa, V. S., Carneiro-da-Cunha, J. A., Nassif, V. M. J., & Giglio, E. M. (2022). Relational influence on entrepreneurial orientation: An exploratory study of small religious enterprises in Brazil. *Journal of Entrepreneurship in Emerging Economies*, *14*(1), 1–22, doi: https://doi.org/10.1108/JEEE-09-2020-0353.

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches*, Thousand Oaks: Sage Publications.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319, doi: https://doi.org/10.2307/249008.

de Filippi, P., Mannan, M., & Reijers, W. (2020). Blockchain as a confidence machine: the problem of trust & challenges of governance. *Technology in Society*, *62*, 1–14, doi: https://doi.org/10.1016/j.techsoc.2020.101284.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behaviour: an introduction to theory and research*, Reading (MA): Addison-Wesley. Retrieved from https://br.search.yahoo.com/search?fr=mcafee&type=E211BR826G0&p=Fishbein%2C+M.%2C+%26+Ajzen%2C+I.+(1975).+

Belief%2C+attitude%2C+intention+and+behaviour%3A+an+introduction+to+theory+and+research.+Reading%2C+MA%3A+Addison-Wesley

Gefen, D., Karahanna, E., & Straub, D. W. (2003). Trust and TAM in online shopping: an integrated model. *MIS Quarterly*, *27*(1), 51, doi: https://doi.org/10.2307/30036519.

Gefen, D., Rose, G. M., Warkentin, M., & Pavlou, P. A. (2011). Cultural diversity and trust in IT adoption. *Journal of Global Information Management*, *13*(1), 54 –78, doi: https://doi.org/10.4018/jgim.2005010103.

Gong, C., & Ribiere, V. (2021). Developing a unified definition of digital transformation. *Technovation*, *102*, doi: https://doi.org/10.1016/j.technovation.2020.102217.

Gössling, T. (2004). Proximity, trust and morality in networks. *European Planning Studies*, *12*(5), 675–689. Retrieved from www.tandfonline.com/doi/abs/10.1080/0965431042000220011 doi: https://doi.org/10.1080/0965431042000220011.

Grech, A., & Camilleri, A. F. (2017). Blockchain in education. In A. Inamorato dos Santos (Ed.), EUR 28778 EN; doi:https://doi.org/10.2760/60649. Retrieved from https://data.europa.eu/doi/10.2760/60649

Han, M., Li, Z., He, J., Wu, D., Xie, Y., & Baba, A. I. (2018). A novel blockchain-based education records verification solution. *Proceedings of the 19th Annual SIG Conference on Information Technology Education*, pp. 178–183, doi: https://doi.org/10.1145/3241815.3241870

Helliar, C. V., Crawford, L., Rocca, L., Teodori, C., & Veneziani, M. (2020). Permissionless and permissioned blockchain diffusion. *International Journal of Information Management*, *54*, doi: https://doi.org/10.1016/j.ijinfomgt.2020.102136.

Iansiti, M., & Lakhani, K. R. (2017). The truth about blockchain. *Harvard Business Review*. Retrieved from https://hbr.org/2017/01/the-truth-about-blockchain

Janssen, M., Weerakkody, V., Ismagilova, E., Sivarajah, U., & Irani, Z. (2020). A framework for analyzing blockchain technology adoption: Integrating institutional, market and technical factors. *International Journal of Information Management*, *50*, 302–309, doi: https://doi.org/10.1016/j.ijinfomgt.2019.08.012.

Jebb, A. T., Parrigon, S., & Woo, S. E. (2017). Exploratory data analysis as a foundation of inductive research. *Human Resource Management Review*, *27*(2), 265–276, doi: https://doi.org/10.1016/j.hrmr.2016.08.003.

Jussani, A. C., de Vasconcellos, E. P. G., Wright, J. T. C., & Grisi, C. C. D H. (2018). Marketing internationalization: Influence factors on product customization decision. *RAUSP Management Journal*, *53*(4), 555–574, doi: https://doi.org/10.1108/RAUSP-07-2018-0043.

Liu, L., Han, M., Wang, Y., & Zhou, Y. (2018). Understanding data breach: A visualization aspect. S. Chellappan, W. Cheng, & W. Li, (Eds). *Wireless algorithms, systems, and applications. WASA 2018. Lecture notes in computer science*, pp. 10874. *Cham*: *Springer*. In: https://doi.org/10.1007/978-3-319-94268-1_81

Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system. Retrieved from https://Bitcoin.Org/Bitcoin.Pdf

Niu, B., Dong, J., & Liu, Y. (2021). Incentive alignment for blockchain adoption in medicine supply chains. *Transportation Research Part E: Logistics and Transportation Review*, *152*, doi: https://doi.org/10.1016/j.tre.2021.102276.

Queiroz, M. M., & Fosso Wamba, S. F. (2019). Blockchain adoption challenges in supply chain: An empirical investigation of the main drivers in India and the USA. *International Journal of Information Management*, *46*, 70–82, doi: https://doi.org/10.1016/j.ijinfomgt.2018.11.021.

Queiroz, M. M., Pereira, S. C. F., Telles, R., & Machado, M. C. (2021). Industry 4.0 and digital supply chain capabilities: A framework for understanding digitalisation challenges and opportunities. *Benchmarking: An International Journal*, *28*(5), 1761–1782. Retrieved from www.emerald.com/insight/content/doi/10.1108/BIJ-12-2018-0435/full/html doi: https://doi.org/10.1108/BIJ-12-2018-0435.

Ralph, A. F., Chadban, S. J., Butow, P., Craig, J. C., Kanellis, J., Wong, G., ... Tong, A. (2020). The experiences and impact of being deemed ineligible for living kidney donation: Semi-structured interview study. *Nephrology*, *25*(4), 339–350, doi: https://doi.org/10.1111/nep.13628.

Rashid, Y., Rashid, A., Warraich, M. A., Sabir, S. S., & Waseem, A. (2019). Case study method: A step-by-step guide for business researchers. *International Journal of Qualitative Methods*, *18*, doi: https://doi.org/10.1177/1609406919862424.

Schiavi, G. S., Behr, A., & Marcolin, C. B. (2019). Conceptualizing and qualifying disruptive business models. *RAUSP Management Journal*, *54*(3), 269–286, doi: https://doi.org/10.1108/RAUSP-09-2018-0075.

Schuetz, S., & Venkatesh, V. (2020). Blockchain, adoption, and financial inclusion in India: Research opportunities. *International Journal of Information Management*, *52*, 101936, doi: https://doi.org/10.1016/j.ijinfomgt.2019.04.009.

Shao, Z., Zhang, L., Brown, S. A., & Zhao, T. (2022). Understanding users' trust transfer mechanism in a blockchain-enabled platform: A mixed-methods study. *Decision Support Systems*, *155*, 113716, doi: https://doi.org/10.1016/j.dss.2021.113716.

Stieglitz, S., Hofeditz, L., Brünker, F., Ehnis, C., Mirbabaie, M., & Ross, B. (2022). Design principles for conversational agents to support emergency management agencies. *International Journal of Information Management*, *63*, 102469, doi: https://doi.org/10.1016/j.ijinfomgt.2021.102469.

Tapscott, D., & Tapscott, A. (2017). How blockchain will change organizations. *MIT Sloan Management Review*, *58*(2), 10–13. Retrieved from www.proquest.com/openview/8c8f32d30dfcdbe4bb4febf1952533ea/1?pq-origsite=gscholar&cbl=26142

Toufaily, E., Zalan, T., & Ben Dhaou, S. (2021). A framework of blockchain technology adoption: An investigation of challenges and expected value. *Information & Management*, *58*(3), doi: https://doi.org/10.1016/j.im.2021.103444.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, *27*(3), 425–478, doi: https://doi.org/10.2307/30036540.

Viriyasitavat, W., Da Xu, L., Bi, Z., & Sapsomboon, A. (2020). Blockchain-based business process management (BPM) framework for service composition in industry 4.0. *Journal of Intelligent Manufacturing*, *31*, doi: https://doi.org/10.1007/s10845-018-1422-y.

Völter, F., Urbach, N., & Padget, J. (2021). Trusting the trust machine: Evaluating trust signals of blockchain applications. *International Journal of Information Management*, doi: https://doi.org/10.1016/j.ijinfomgt.2021.102429.

Wamba, S. F., & Queiroz, M. M. (2022). Industry 4.0 and the supply chain digitalisation: A blockchain diffusion perspective. *Production Planning & Control*, *33*(2-3), 193–210, doi: https://doi.org/10.1080/09537287.2020.1810756.

Wan, Y., Gao, Y., & Hu, Y. (2022). Blockchain application and collaborative innovation in the manufacturing industry: Based on the perspective of social trust. *Technological Forecasting and Social Change*, *177*, doi: https://doi.org/10.1016/j.techfore.2022.121540.

Wang, J., Wu, P., Wang, X., & Shou, W. (2017). The outlook of blockchain technology for construction engineering management. *Frontiers of Engineering Management*, *4*(1), 67–75. Retrieved from https://journal.hep.com.cn/fem/EN/10.15302/J-FEM-2017006 doi: https://doi.org/10.15302/J-FEM-2017006.

Wendland, J., Lunardi, G. L., & Dolci, D. B. (2019). Adoption of health information technology in the mobile emergency care service. *RAUSP Management Journal*, *54*(3), 287–304, doi: https://doi.org/10.1108/RAUSP-07-2018-0058.

Wong, L. W., Tan, G. W. H., Lee, V. H., Ooi, K. B., & Sohal, A. (2020). Unearthing the determinants of blockchain adoption in supply chain management. *International Journal of Production Research*, *58*(7), 2100–2123, doi: https://doi.org/10.1080/00207543.2020.1730463.

Yin, R. K. (2014). *Estudo de caso – Planejamento e métodos*, (5. ed., p. 320), Porto Alegre (Brazil: Bookman. Retrieved from https://books.google.com.br/books?id=EtOyBQAAQBAJ

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