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Digital transformation in higher education institution management: key aspects for blockchain adoption



La transformación digital en la gestión de instituciones de educación superior: aspectos clave para la adopción de blockchain

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Abstract

The article presents a framework that highlights the relationships between key aspects related to digital transformation through blockchain in the context of Higher Education Institution management. We developed this framework using the Design Science Research methodology, which involved three validation phases and 23 interviews. A total of 16 key aspects were identified, namely: IT Governance, change mapping, internal and external motivations, organizational culture, change in value creation, structural changes, financial aspects, digital strategies, regulatory frameworks, adoption of technologies, types of approach (student and/or institution-centered), safety standards, interoperability of transactions, auditability, authenticity, and decentralization. This study contributes not only to the identification and description of these key aspects within the context of Higher Education Institutions but also to overcoming the traditional teaching/learning approach when it comes to the adoption of technologies in Higher Education Institutions, including elements for their organizational management.

Keywords: Blockchain; Digital Transformation; Higher Education Institutions; Design Science Research.

Resumen

El artículo presenta un framework que resalta las relaciones de los aspectos clave relacionados con la transformación digital a través de blockchain en el contexto de la gestión de Instituciones de Educación Superior. Se desarrolló este framework utilizando la metodología de Investigación en Ciencia del Diseño, que implica tres fases de validación dentro de 23 entrevistas. Se identificaron un total de 16 aspectos clave, a saber: IT Governance, mapeo del cambio, motivaciones internas y externas, cultura organizacional, cambio en la creación de valor, cambios estructurales, aspectos financieros, estrategias digitales, marcos regulatorios, adopción de tecnologías, tipos de enfoque (centrado en el estudiante y/o en la institución), estándares de seguridad, interoperabilidad de las transacciones, auditabilidad, autenticidad y descentralización. Este estudio contribuye no solo a la identificación y descripción de estos aspectos clave orientados al contexto de las Instituciones de Educación

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Superior, sino también a la superación del enfoque de enseñanza/aprendizaje cuando se trata de la adopción de tecnologías en las Instituciones de Educación Superior, incluyendo elementos para su gestión organizacional.

Palabras clave: Blockchain; Transformación Digital; Instituciones de Educación Superior; Investigación basada en el diseño.

Introduction

Changes linked to digital technologies that enable new ways of thinking and conducting business are transforming organizations (Olleros & Zhegu, 2016). Thus, there is a perceived need to strategize, optimize processes, digitize products and services, and innovate business models (Hess et al., 2016). These contextual changes generate greater adherence to various initiatives mediated by digital technologies (Westerman et al., 2014; Bharadwaj et al., 2013; Marks et al., 2020), which have the potential to transform organizations while enhancing their competitiveness (Vial, 2019; Bharadwaj et al., 2013; Karimi & Walter, 2015; Matt et al., 2015). Among recent technologies, blockchain has the potential to significantly impact society, including driving digital transformation in organizations (White, 2017).

In this context, Higher Education Institutions (HEIs) have begun investing in blockchain technology to enhance digitization and security in processes, particularly to facilitate management and access to students' academic documents (Kam & Katerattanakul, 2010). In Europe and United States, projects focusing on the digital transformation of HEIs through blockchain technology are underway (Yakovenko et al., 2019). In 2019, the Community University of Chapecó (Unochapecó) in Brazil launched a project that adopted blockchain technology for storing class diaries, ensuring data integrity, traceability, and inviolability (Unochapecó, 2019).

Therefore, a promising scenario is emerging for HEIs, where blockchain technology enables the digital transformation of educational processes, despite the field being relatively nascent (Bhaskar et al., 2020). Simultaneously, research is necessary to understand the aspects involved in blockchain technology adoption related to digital transformation in education (Loukil et al., 2021). Recent studies have highlighted the growing interest in implementing blockchain solutions in higher education. For example, Gottlieb (2024) identifies new scenarios for blockchain in HEI management, emphasizing its role in secure data sharing and the democratization of academic credentials. Bravo-Jaico et al. (2025) demonstrate that blockchain, alongside AI and other technologies, has been driving digital transformation by improving data management and institutional processes.

Furthermore, recent reviews underscore blockchain's capacity to foster collaboration, enhance transparency, and support the development of decentralized academic infrastructures (Kayanja, 2025; Toader et al., 2023). Given these growing interests and knowledge gaps concerning the adoption of blockchain in HEI digital

transformation processes, further research is needed. So, the guiding question of this article is: What are the key aspects that should be considered in this process?

We adopted the Design Science Research (DSR) methodology, grounded in the conceptual foundations of digital transformation and blockchain technology, combined with the empirical data gathered from technology professionals and HEI managers. As a theoretical contribution, this article identifies and describes the key aspects related to digital transformation through blockchain in the context of HEIs, which are: IT Governance, change-mapping, internal and external motivations, organizational culture, change in value creation, structural changes, financial aspects, digital strategies, regulatory frameworks, adoption of technologies, types of approach (student and/or institution-centered), safety standards, interoperability of transactions, auditability, authenticity, and decentralization.

Regarding managerial contribution, we have developed a tool that outlines a course of action from macro to micro levels, serving as managerial support for future demands involving the digital transformation of HEIs via blockchain. This tool serves as a guide or mental map, indicating the key aspects to be analyzed by HEI managers in each specific context. It emphasizes the significance of the “Type of Approach” aspect, which, although contextualized in terms of ‘students’, can be re-framed as ‘clients/users’, thereby complementing the proposition by Janssen et al. (2020), which encompasses aspects of process changes, institutional factors, market factors, and technical factors influencing blockchain technology adoption.

Theoretical Framework

Digital Transformation

Digital transformation can be considered both a social phenomenon and a redesign of business models (Stolterman & Fors, 2004; Zhu et al., 2006; Berman, 2012) with the potential to radically improve organizational performance (Westerman et al., 2014). Digital technologies underscore the significance of information, data, and knowledge as essential components of daily activities (Zimmermann et al., 2018). Digital transformation is a process in which digital technologies create disruptions, triggering strategic responses from organizations to alter their value creation paths, while requiring management of structural changes and organizational barriers (Vial, 2019), and a pursuit of organizational flexibility, agility, and responsiveness (Chew, 2013).

Matt et al. (2015) proposed a conceptual framework for digital transformation that includes financial considerations, structural changes, shifts in value creation, and the adoption of technology. Additionally, the assessment of technology adoption addresses the IT role alongside organizational responses, as an organization’s focus

may shift based on planning and internal acceptance of new digital technologies (Matt et al., 2015; Hess et al., 2016; Stief et al., 2016).

The adoption of new technologies establishes precedents that lead to changes in how organizations create value (Matt et al., 2015). Adopting new technologies and altering value creation necessitate structural changes to build a solid foundation for new operations (Matt et al., 2015). This dimension encompasses the responsibility required for digital transformation, decisions regarding the integration of existing structures and activities, the development of new capabilities and competencies, and the operational changes expected during the process (Berman, 2012; Hess et al., 2016). However, these dimensions lead to disruptive changes, particularly when financial considerations are taken into account (Karimi & Walter, 2015). This occurs as a result of significant investments in new technologies and the need to balance funding across existing organizational activities (Matt et al., 2015; Stief et al., 2016).

As a catalyst for organizational change, digital transformation progresses through two fundamental stages. First, leadership awareness and meaning-making regarding the change process shape a culture oriented toward digital transformation. Second, the formulation of digital strategies, which encompasses defining characteristics, setting objectives, and developing procedural measures aimed at successful adaptation to anticipated changes (Serna et al., 2010; Kane et al., 2015; Sá & Serpa, 2020).

In the context of HEIs, there is a trend toward the adoption of various technologies to drive digital transformation (Jacociunas et al., 2024). Thus, information and communication technologies are being leveraged to enhance management of students' records and access to academic documentation (Kam & Katerattanakul, 2010). This gradual change in higher education was accelerated by the onset of the COVID-19 pandemic (Sá & Serpa, 2020). Therefore, successful transformation requires not only the adoption of digital technologies but also the engagement of the entire educational management process (Benavides et al., 2020).

The primary focus of digital transformation initiatives has been on learning (Benavides et al., 2020; Gasevic et al., 2015; Skulmowski & Rey, 2020), though initiatives targeting academic management also exist (Kam & Katerattanakul, 2010). Nevertheless, Fernández et al. (2023) concluded that HEIs are still at an early stage of digital maturity.

Blockchain Technology

Blockchain is a digital ledger that enables data sharing and maintains a history of executed transactions (Cheng et al., 2018; Bhaskar et al., 2020; Verschoore et al., 2021). Its main features include immutability, as all transactions are permanent and irrevocable; decentralization, since transactions are recorded on a public ledger accessible to any network node; consensus verification, whereby each block is

independently verified; and transparency, with all transactions accessible to relevant parties (Sultan et al., 2018).

In the context of digital transformation, blockchain technology is used to manage organizational processes, interactions and facilitate secure data sharing. However, according to Hughes et al. (2019), it is crucial for organizations to first understand the problems they face before determining whether blockchain solutions effectively address these issues. As digital transformation drives organizational changes, companies should undertake holistic socio-technical transformation, update business processes and engage in ongoing dialogue with stakeholders (Mori, 2016; Legner et al., 2017). In this sense, Imgrund et al. (2018) emphasize the need for comprehensive security standards, guidelines and rules to mitigate the risks posed by emerging IT threats and to preserve the integrity of transacted data and information (Benavides et al., 2020). Risk management helps organizations identify infrastructure vulnerabilities and inherent threats (Casino et al., 2019; Imgrund et al., 2018; Janssen et al., 2020).

When implementing blockchain technology, prioritize interoperability and auditability. Interoperability automates processes to overcome technological diversity, while auditability ensures transaction transparency and traceability. The inherent features of blockchain — transparency and immutability — ensure that all records are fully auditable (Casino et al., 2019; Viriyasitavat & Hoonsopon, 2018; Janssen et al., 2020).

In HEIs, blockchain enables the education system to align more closely with developmental needs associated with the shared and digital economy model (Duan et al., 2017). According to recent research, implementing this technology enables the creation of an immutable, distributed, auditable and secure database, streamlining the issuance and validation of certificates (Gartner, 2019; Di Francesco Maesa & Mori, 2020). Moreover, redesigning online courses with blockchain technology can improve both teaching quality and trust in the online education system (Min & Bin, 2022).

Across Europe, Asia, and the US, blockchain technology is notable for its capacity to track learning and reduce document forgeries (Yakovenko et al., 2019; Sun et al., 2021). In Brazil, research in the HEIs context has focused on diploma registration and validation, as the Federal University of Paraiba (UFPB), which aims to provide Brazilian federal universities with a system for registering certificates on a blockchain and enabling external organizations to verify document authenticity (Costa et al., 2018). Blockchain has also been utilized for storing class diaries, enhancing data integrity and traceability, as demonstrated in a project at Universidade Comunitária da Região de Chapecó (UNOCHAPECÓ) in southern Brazil (Unochapecó, 2019).

According to Loukil et al. (2021), the benefits of adopting blockchain in HEIs include increased accountability and transparency, enhanced protection and verification of credentials and certificates, improved data access control and identity authentication, better management of student records, and the preservation

of privacy, along with increased student interactivity. Additional benefits include cost reductions, greater transaction efficiency, and relieving HEIs from being solely responsible for data protection and privacy, in line with the General Data Protection Regulation (Matthews, 2018; Hope, 2019; Castro & Au-Yong-Oliveira, 2021; Loukil et al., 2021).

Method

We employ Design Science Research (DSR). This methodology operationalizes research when the goal is to develop an artifact (Van Aken, 2004) that enables the researcher to find a satisfactory solution to practical problems encountered in the field (Hevner et al., 2004; Çağdaş & Stubkjær, 2011). First, we conducted a literature review to support the description of key aspects related to digital transformation and blockchain technology. Subsequently, we developed the Framework Zero (F0) and presented it to a blockchain technical expert for initial validation. The artifact was proposed to function as a mind map, serving as a support tool for HEI managers in strategic planning. According to Buzan (2018), a mind map is a technique that assists the process of hierarchizing thoughts and better understanding information about a given topic.

To evaluate the developed artifact and ensure reliability to the study (Venable et al., 2012; Prat et al., 2015), we define the types of evaluation applied to the different versions of the framework: (i) analytical evaluation – through 21 semi-structured interviews conducted with technology professionals and HEI managers (with audio recording and transcription of the content), as detailed in **Table 1**, and (ii) descriptive evaluation – validation of empirical evidence through theoretical reference. The interviewees were selected using the snowball sampling technique (Parker et al., 2019).

Table 1. Analytical Evaluation Data

Framework Version	Initial Artifact	F0	F1	F2
Objective	Validate proposed framework	Validate F0 version	Validate F1 version	Validate F2 version
Interviewees	01 technology professional from UNOCHAPECÓ)	A total of 09 interviews (I1 to I9): - 05 technology professionals. - 03 technology professionals from UNOCHAPECÓ. - 01 technology professional/author in blockchain (international)	A total of 06 interviews (I10 to I15): - 04 technology professionals. - 02 technology professionals from UFPB.	A total of 06 interviews (I16 to I21): - 06 HEI managers.

Four evaluation criteria were considered: (i) usefulness - the artifact must be considered useful to achieve the intended goal, (ii) flexibility – the artifact needs to perform effectively in various contexts, (iii) completeness – it must contain all the essential elements to fulfill its purpose, and (iv) suitability to the organization – the artifact must be applicable within HEIs oriented towards digital transformation involving blockchain technology.

Results and Discussion

Based on the proposal by Matt et al. (2015) and expanded to include key aspects related to digital transformation and blockchain technology, we developed the Framework Zero (F0), which is presented in **Table 2**, and preliminarily validated by a technology professional.

Table 2. Framework Zero (F0)

Approach	Key Aspects	Description	References
Digital transformation	Changes in Value Creation	This represents the influence of digital transformation on the value creation for the organization and its stakeholders.	Berman (2012); Matt <i>et al.</i> (2015); Stief; <i>et al.</i> (2016); Janssen <i>et al.</i> (2020)
	Structural Changes	This refers to changes involving the organizational structure, processes, and skills required for adapting to new technologies.	Berman (2012); Matt <i>et al.</i> (2015); Hess <i>et al.</i> (2016); Janssen <i>et al.</i> (2020)
	Financial Aspects	This reflects the need to act in response to business challenges and the ability to finance the process.	Karimi & Walter (2015); Matt <i>et al.</i> (2015); Stief <i>et al.</i> (2016)
	Technology Adoption	This reflects the organization’s ability to exploit new digital technologies.	Matt <i>et al.</i> (2015); Hess <i>et al.</i> (2016); Stief <i>et al.</i> (2016)
	Organizational Culture	This represents the need for leadership awareness, as well as awareness of the organizational culture (human capital aspects) involved.	Serna <i>et al.</i> (2010); Kane <i>et al.</i> (2015); Sá & Serpa (2020)
	Digital Strategies	This refers to the organizational characteristics, goals, and challenges associated with digital transformation.	Serna <i>et al.</i> (2010); Kane <i>et al.</i> (2015); Sá & Serpa (2020)
Blockchain technology	Security Standards	This approach involves rules that arise from the risks associated with the digital transformation process, aiming to secure data, information, and transactions.	Imgrund <i>et al.</i> (2018); Casino <i>et al.</i> (2019); Benavides <i>et al.</i> (2020); Janssen <i>et al.</i> (2020)
	Transaction Interoperability	This refers to the automation of procedures and operations, aiming to mitigate the difficulty of standardization arising from the diversity of technological solutions.	Viriyasitavat & Hoonsopon (2018); Casino <i>et al.</i> (2019); Janssen <i>et al.</i> (2020)
	Auditability	This refers to the transparency that provides the traceability of an operation recorded in a database.	Viriyasitavat & Hoonsopon (2018). Casino <i>et al.</i> (2019), Janssen <i>et al.</i> (2020)

The F0 was analyzed and validated by nine technology professionals with consolidated market performance.

Framework Zero(F0) Evaluation

The practical relevance of the presented aspects was questioned, leading to the emergence of new key aspects. The importance of defining the digital transformation process of HEIs was highlighted in order not to confuse it with digitization. As per I3:

[...] “Some institutions have been going through a process, here summarized in turning manual processes into digital ones [...]. Digital transformation is the culmination of this, as it involves multiple actors and presupposes a level of maturity that enables a holistic view of the process itself. I think defining the approach is essential in order to understand the idea of changing the whole.” (Interviewee 3, personal communication, 2024).

According to Legner et al. (2017), digitization primarily concerns the use of digital technologies; however, *Digital transformation* encompasses not only technological adoption but also involves the actors in the process, their characteristics, skills, and required behaviors. Gong and Ribiere (2020) define digital transformation as “a process of fundamental change, enabled by the innovative use of digital technologies accompanied by the strategic leveraging of core resources and capabilities, to radically improve an entity and redefine its value proposition” (p. 12).

Two critical aspects positioned at the beginning of the artifact are *internal motivation*, described by I3 as a form of stimulus to change, “[...] one must think why to go through this process of digital transformation?” (Interviewee 3, personal communication, 2024) and *external motivation*, as highlighted by I9: “From the competitive pressure, the environment of innovation and disruption is internally and externally influenced, whether regarding possible changes that will depend on the core business of the business, or its adaptation needs, facing the market in which it operates” (Interviewee 9, personal communication, 2024).

Kane et al. (2015), Kaufman and Horton (2014), and Benavides et al. (2020) emphasize that internal motivations often stem from efforts to generate social and economic benefits, promoting increased interaction and collaborative engagement with customers. External motivations include rising competition in the digital environment or global-scale events, such as a pandemic, which inevitably drive companies toward change (Kohli & Johnson, 2011; Von Leipzig et al., 2017; Sá & Serpa, 2020).

Regarding the blockchain technology, additional aspects were addressed: the reliability of the process, through the verification of the *authenticity* of transactions, for being “an important property, linked to the blockchain technology, thinking about benefit or delivery” (Interviewee 9, personal communication, 2024); the importance

of the *decentralization* of the process “because, precisely, it goes against the opposite idea (centralized businesses)” (Interviewee 8, personal communication, 2024).

In the technology adoption process, two aspects stand out: the *type of student-centered approach*, in which “from the moment that all this is in the blockchain, this data is no longer from the university, it will be distributed among us, which increases the power of the network and the student becomes the protagonist of this, being the focus turned to him” (Interviewee 4, personal communication, 2024) and *type of institution-centered approach*, according to I2, “the set of aspects of this approach, starting from the logic of peer to peer, will make sense depending on what one aims to achieve and here, on whom one wants to focus: student, the institution itself, etc.” (Interviewee 2, personal communication, 2024).

Authenticity is essential as it ensures reliable transacted information, serving as a digital fingerprint of records (Grech & Camilleri, 2017; Bandara et al., 2018; Frizzo-Barker et al., 2020). Decentralization enables transactions without relying on a central authority, which encourages cost reduction, mitigates performance bottlenecks, and fosters fairness and security in protocols (Han et al., 2018; Frizzo-Barker et al., 2020). Regarding the types of approach (student-centered/institution-centered), Mezquita et al. (2019) state that it is necessary to recognize two distinct approaches to blockchain adoption in academic environments: student-centered and institution-centered. Consequently, Framework One (F1), presented in **Table 3**, incorporates these additions and adjustments following this validation.

Table 3. Framework One (F1)

Approach	Key Aspects	Description
Digital transformation Change that considers the adoption of digital technology evolves into a holistic transformation of the organization, seeking to create value [inclusion of description]	Internal Motivation [inclusion of new aspect positioned at the beginning]	It relates to internal factors associated with efficiency and/or productivity indicators that stimulate change, such as sales levels, financial pressure, and differentiation
	External Motivation [inclusion of new aspect positioned at the beginning]	It relates to aspects that stimulate change externally, such as the pace of technological development, shifts in modes of interaction between organizations, sectoral transitions, and adaptability in response to market forces, including competition
Blockchain technology A digital ledger that provides data sharing in a transparent, decentralized, immutable, and tamper-proof manner. Data can be read and verified, but not deleted, maintaining a history of every executed transaction [description included]	Authenticity [inclusion]	It refers to the validation of recorded transactions through a cryptographic hash (i.e., a fingerprint) on the blockchain, which attests to the reliability of the record.
	Decentralization [inclusion]	It assumes that a transaction on the blockchain network can be executed without requiring authentication from a central server or the involvement of intermediary agents.
	Type of Approach: Student-Centered [inclusion]	The HEI's focus shifts to the premise that academic data control belongs to the student.
	Type of Approach: Institution-Centered [inclusion]	The HEI's focus is on optimizing activities related to the institution's academic management.

The evaluation of the F1 version included the analysis of 06 other technology professionals with a solid performance in the technology market.

Framework One (F1) Evaluation

In this second validation, the research team questioned the practical relevance of the aspects presented after adjusting the previous version. The empirical findings indicated, in addition to the inclusion of a new key aspect, the repositioning and merging of other aspects within the framework. This new aspect of the artifact was considered essential to the process, as it involves continuous monitoring of the impacts within the business environment, specifically *change mapping*. This is evident in the words of I13: “I would include process mapping, something like that, in the logic of monitoring, managing that change, checking the current stage and how this is impacting the institution” (Interviewee 13, personal communication, 2024). Matt et al. (2015) state that companies need to make decisions from this mapping, aiming to identify the processes that may be affected by the adoption of new technologies. Predictive analytics capabilities are essential in this context for achieving process optimization, as well as identifying potential problems, vulnerabilities, and associated risks (Berman, 2012; Kaufman & Horton, 2014). Zaoui & Souissi (2020) reiterate the importance of this constant multidimensional evaluation, i.e., that goes through the different stages involved in digital transformation, seeking to analyze the efficiency of the measures adopted during the process.

Regarding the aspects of the type of approach, student-centered and institution-centered, they should be listed in the same section in an integrated manner, because the approach adopted may consider either one of the approaches, or both, resulting in *types of approaches: student-centered and/or institution-centered*. In this sense, I11 comments: “Depending on the type of institution, the focus of the approach will be on the student; moreover, most of the time, considering the data use agenda; however, sometimes the strategy may also be focused on process optimization” (Interviewee 11, personal communication, 2024).

This previous adjustment aligns with what Mezquita et al. (2019) state, highlighting distinct approaches to implementing blockchain-based solutions in the academic environment. Regarding the positioning of this aspect, it was considered to list it at the beginning of the framework where blockchain technology is addressed, as per I11: “[...] I would reallocate it as the first need, positioning it as something that I will see first when thinking about this technology adoption process” (Interviewee 11, personal communication, 2024).

Regarding the repositioning of other key aspects already existing in the model, *organizational culture* was listed as one of the analysis priorities, positioned at the beginning of the artifact, in terms of the defined objectives within the analyzed context. I14 brings the mentioned importance:

“[...] one of the most important constructs concerns organizational culture, both in the sense of managers and other leaders becoming aware of the real value in adopting technology as an element of transformation when applied to some specific aspect, as well as in the sense of the general public that will be dealing with a technology that can only deliver its real value when everyone is part of the support and operation process...” (Interviewee 14, personal communication, 2024).

The aspect concerning organizational culture is seen as a determinant for successful transformations involving digital technologies, as it encompasses skills and competencies to be developed, as well as the promotion of a digital transformation-oriented mindset (Kane et al., 2015; Gebretsadik, 2020). It also highlighted the need to reposition the aspect of *technology adoption* in relation to digital technology being discussed, as it is necessary to understand that technology will only be a solution when there is an understanding of the institution’s need to carry out the digital transformation process. I15 comments that “each organization will be guided by a specific goal or need. And, in this case, technology would be a means and not the end; so, understanding where one wants or needs to get to be crucial” (Interviewee 15, personal communication, 2024).

Thus, the new empirical evidence discussed here, and supported by the literature, validated the F1 version, promoting adjustments in the model and generating Framework Two (F2), presented in **Table 4**, only with additions or adjustments of this step:

Table 4. Framework Two (F2)

Approach	Key Aspects	Description
Digital transformation	Organizational Culture [repositioned at the beginning of the artifact]	
	Technology Adoption [repositioned at the end of the artifact]	
	Change Mapping [inclusion of new aspect]	It involves the ongoing verification and monitoring of the impact generated in the business environment from digital transformation.
Blockchain technology	Types of Approaches: Student-Centered and/or Institution-Centered [merging and repositioning to the beginning]	The focus of the HEI may shift to the premise that control of academic data resides with the students. Alternatively, it may concentrate on optimizing activities related to the institution’s academic management.

The F2 version, which includes the remaining aspects of the F1 version that were not altered, was validated by 06 HEI managers nationwide. The discussion of these results is presented in the following section.

Framework Two (F2) Evaluation

In the final validation stage, the research team assessed the usefulness of the artifact and questioned the relevance of the aspects presented to HEI managers. A new key aspect was introduced, referring to the legal aspects that influence the transformation of HEIs, specifically *the regulatory frameworks*. In this sense, I16 reflects: “[...] the regulatory frameworks can also be considered, such as the MEC ordinances that are already dealing with the topic, maybe addressing an aspect that talks about important norms or regulations to be analyzed” (Interviewee 16, personal communication, 2024).

This point is further corroborated by existing initiatives, particularly within education sector, such as the “Digital Diploma” program, a technological innovation project developed by the National Education and Research Network (RNP), linked to the Brazilian Ministry of Education (MEC), which came into force in 2020 in five HEIs: Federal University of Paraná (UFPR), Federal University of Paraíba (UFPB), Federal University of Rio Grande do Norte (UFRN), Federal University of Sergipe (UFSE) and Federal Institute of Rio Grande do Norte (IFRN). The program issues and/or registers the diploma in digital format, aiming to modernize the procedural flow, bringing greater transparency, agility, fairness, and interoperability of data, as well as reducing costs and time involved in the process (Costa Silva, 2021).

As for the regulation involved in HEIs, in general, digital transformation is highly motivated by government policies, aiming at the digitalization of these institutions, by redefining their services or by remodeling operational processes (Walker et al., 2016). As pointed out by Haas (2010), it is relevant that academic managers observe and become familiar with legal norms and guidelines that regulate Brazilian HEIs, as these are one of the motivators for change.

In this validation round, *the change mapping* was considered inherent to the different phases of a digital transformation process in the HEI environment; thus, it would be ideal to contemplate this aspect in parallel with the other aspects. As I16 points out: “I understand that change mapping must follow different phases of the project, estimating possible impacts and respective solutions, until stability is reached, or in this case, the desired goal” (Interviewee 16, personal communication, 2024). This aligns with the provisions in the literature regarding predictive capability, particularly in addressing problems and anticipated risks. It even reiterates the importance of reviewing, at different stages, the need to generate greater collaboration to adequately fulfill the process, according to the needs involved in the institution’s change (Matt et al., 2015; Kane et al., 2015). The new empirical evidence

resulted in the final version of the framework (Figure 1 and Table 5), which was considered satisfactory from the perspective of the HEI managers who participated in this research.

In addition, we have incorporated IT Governance as an aspect that should be present in managerial decision-making and be adapted as Changing Mapping occurs. We leverage IT’s roles and responsibilities to ensure it complements the proposed framework (De Vaujany et al., 2018). Implementing IT Governance roles and responsibilities enhances the outcomes generated by the framework (Tallon et al., 2013; Juiz et al., 2022). This integration is particularly feasible since IT Governance is already an established reality in HEIs (Bianchi & Sousa, 2016).

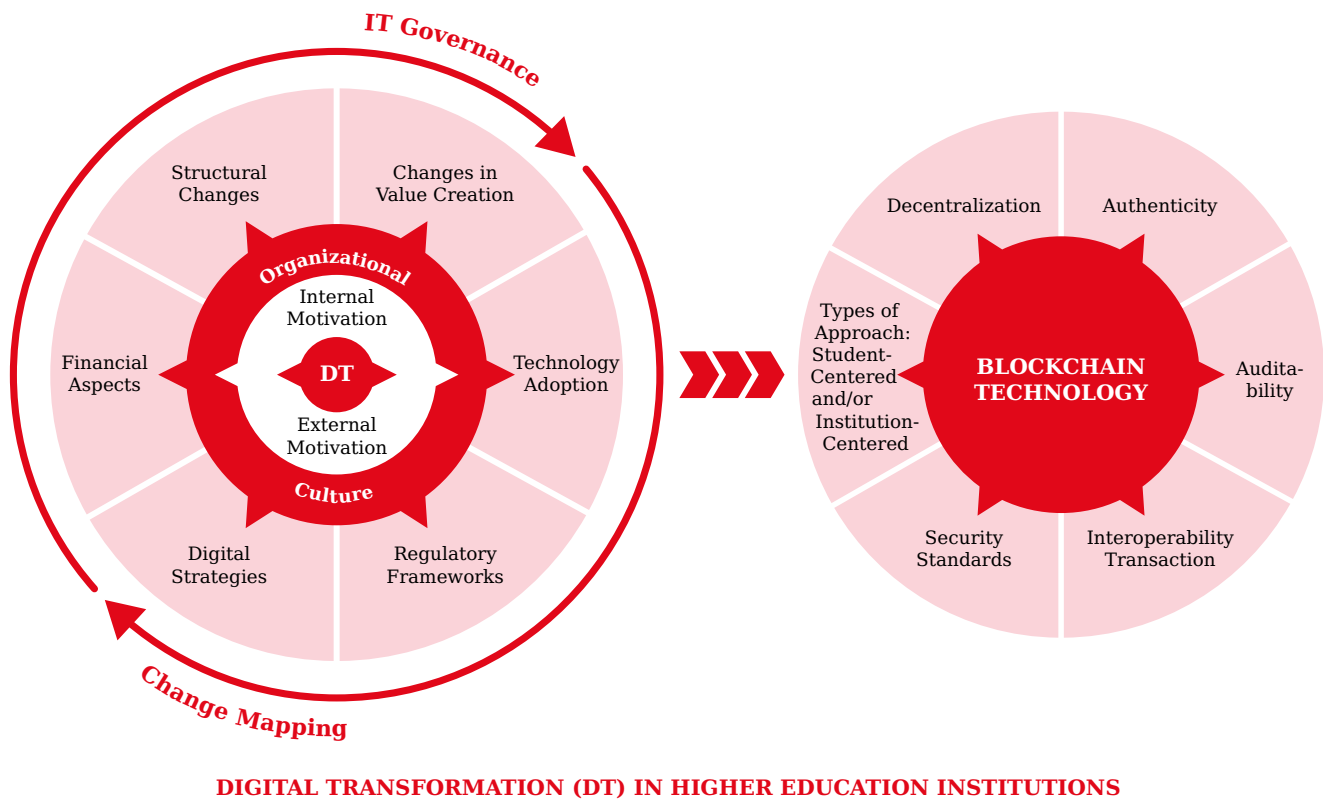


Figure 1. Final Framework (FF)

Considering the digital transformation process in HEI, the framework indicates that the process should be constantly monitored through change mapping. IT Governance is also added as an essential aspect for defining roles and responsibilities, ensuring that the entire digital transformation process is aligned with the HEI’s strategic objectives. With this, it is verified in the context that both internal and external motivations for change are relevant, and organizational culture is indispensable, as values, behaviors, and organizational beliefs must be consistent with the key aspects involved, including the adoption of new technology.

Table 5. Final Framework (FF) part 2: elements of DT in HEI

<p>Digital Transformation Organizational change that considers the adoption of digital technology, but evolves into a holistic transformation of the organization, aiming to create value.</p>	<p>Regulatory Frameworks It deals with the legal norms and guidelines that regulate higher education institutions and influence their digital transformation processes.</p>
<p>Change-mapping It involves verifying and monitoring the impact generated in the business environment by digital transformation.</p>	<p>Technology Adoption It reflects the organization's ability to exploit new digital technologies.</p>
<p>Internal Motivation It relates to efficiency and/or productivity indicators that stimulate change internally.</p>	<p>Blockchain Technology It's a digital ledger that provides data sharing in a transparent, decentralized, immutable, and inviolable way, keeping a history of every executed transaction.</p>
<p>External Motivation It relates to aspects that stimulate change and the reflection in the forms of interaction between organizations, the transition between sectors, and adaptability to the market.</p>	<p>Types of Approach: Student-Centered and/or Institution-Centered The HEI's focus may shift to the premise that the student is in control of their academic data, or it may also focus on optimizing activities involving the institution's academic management.</p>
<p>Organizational Culture It represents the need for leadership awareness, as well as awareness of the organizational culture (human capital aspects) involved in digital transformation.</p>	
<p>Changes in Value Creation Represents the influence of digital transformation on the organization's value creation and the parties involved.</p>	<p>Security Standards This approach addresses the rules and guidelines that arise from the risks involved in the digital transformation process, with a focus on securing data, information, and transactions.</p>
<p>Structural Changes It refers to the changes involving the organizational structure, as well as the processes and skills required for adapting to new technologies.</p>	<p>Transaction Interoperability It refers to the automation of procedures and operations, aiming to mitigate the difficulty of standardization arising from the diversity of technological solutions.</p>
<p>Financial Aspects It relates to the need to take action in the face of business difficulties, as well as the ability to finance the digital transformation process.</p>	<p>Auditability It refers to the need for transparency that provides the traceability of an operation registered in a database.</p>
<p>Digital Strategies It refers to the organizational characteristics, goals, and challenges of digital transformation.</p>	<p>Authenticity It refers to the validation of the recorded transaction with a cryptographic hash (fingerprint) on the blockchain, attesting to the reliability of the record.</p>
<p>IT Governance It involves allocating specific IT governance roles and responsibilities, which is crucial for enhancing the framework's outcomes.</p>	<p>Decentralization Assumes that a transaction on the blockchain network can be performed without relying on authentication from a central server and without intermediaries.</p>

Regarding technological adoption, the specific definitions of blockchain technology that can be adjusted to each HEI digital transformation project are highlighted: security standards, transaction interoperability, auditability, authenticity, and decentralization. The types of guiding approaches are added: student-centered, HEI-centered, or both, depending on the context initially analyzed by the institution. Thus, there are five other 5 key aspects interconnected at a micro level, which must be considered in the digital transformation process of HEIs: financial aspects, digital strategies, regulatory frameworks, structural changes, and changes in value creation.

Main differences and advances from Framework Zero to Final Framework

Framework Zero (F0) was based on central aspects of digital transformation, including changes in value creation, structural shifts, financial considerations, and technology adoption, as well as blockchain dimensions such as security, interoperability, auditability, and decentralization. As the versions progressed, especially in Final Framework (FF), new aspects were incorporated, such as IT Governance, change mapping, internal and external motivations for transformation, organizational culture, digital strategies, and regulatory framework, making the framework more comprehensive.

The final version reorganized the position of aspects to reflect their practical and relational importance. For example, organizational culture was repositioned at the beginning of the framework, emphasizing its fundamental role in the success of digital transformation. Previously separate approaches, centered on the student or the institution, were integrated into a joint approach, recognizing that HEIs may choose or combine these perspectives. Furthermore, the Final Framework strengthens the inclusion of legal and regulatory norms, which directly influence the process of digital transformation in HEIs, a dimension absent in F0. This adds a critical component for the applicability and sustainability of digital initiatives.

The change process is understood as dynamic and continuous, requiring constant monitoring of impacts and adjustments throughout the digital transformation, which was incorporated from intermediate evaluations until FF. Lastly, for this artifact to be useful, it must clarify which aspects within the HEI and its processes need to be considered, as well as their priority, since the tool developed is intended to provide managerial support for future demands involving the digital transformation of HEIs via blockchain. Thus, the proposed framework serves as a cognitive model and hands-on reference for tracking digital transformation processes in HEIs. Nevertheless, managers must consider the strategic objectives and the specific institutional contexts to each setting.

Conclusions

The article addresses the adoption of blockchain technology in HEIs in the context of digital transformation. We employ the Design Science Research methodology to develop a framework that assists HEI managers in navigating the key aspects listed and their existing relationships. The starting point was the conceptual framework of Matt et al. (2015), composed of three key aspects for evaluating technology adoption: structural changes, changes in value creation, and financial aspects. We also added elements involving organizational culture, digital strategies, and the process of mapping the changes generated by digital transformation.

The discussion of blockchain within digital transformation reveals critical considerations, including organizational culture, the formulation of a digital strategy, and the institution's internal and external motivations for adoption. Our analysis further underscores the significance of the HEI's chosen approach —student-centered, institution-centered, or both —as well as key factors such as data security, interoperability, transparency, reliability, and decentralization. As of the empirical validation conferred by technology professionals, during the versions presented in the study – F0, F1, and F2, the relevance of the aspects in the practical context was ratified since the model was considered satisfactory and useful by the interviewees when thinking about the blockchain technology involved in the digital transformation of HEIs. Thus, the developed framework serves as a mental map or practical guide for monitoring digital transformation processes in HEIs.

These validations constitute the theoretical and empirical contribution of the study in identifying and describing the key aspects relevant to the HEI context. In this way, it is expected that HEIs will benefit from the advantages highlighted by Loukil et al. (2021) in the adoption of blockchain technology, and this contributes to the integration of DT in a plan that could yield a high strategic return value to the organization (Fernández et al., 2023). In addition, our research differs from other proposals because the framework's elaboration involves the agents responsible for the technical and managerial implementation of blockchain technology. Therefore, the contributions are not only a theoretical concept without practical validation (Haque et al., 2023).

As a research limitation, the choice of a specific group of managers and technology professionals for the interview is noted. However, this can be overcome by developing an online questionnaire that expands the quantity and diversity of respondents. Furthermore, although the choice was made to serve HEIs, the adjustments can be adapted for service providers, dealing with “client/user” instead of “student,” in addition to adjustments according to the business area.

Future research could further develop this framework by creating measurable scales or indicators, thereby transforming it into a more adaptable tool suitable for broader institutional applications. These adjustments may contribute to diagnosing the institution's stage in the digital transformation process and objectively directing

the organizational actions. Additionally, new qualitative explorations may deepen the discussion of the aspects presented and serve as a subsidy for other levels of analysis of the HEIs. Moreover, comparative analyses among diverse institutional profiles and regions are recommended to identify variations in digitalization processes and blockchain adoption. Further investigation into cultural, regulatory, and technical barriers is crucial to support the development of effective strategies for overcoming digital transformation challenges.

Finally, we emphasize that organizations, especially HEIs, find themselves in a context where digital technologies have become part of organizational processes, requiring greater attention to digital transformation. Thus, blockchain technology can contribute to this process by overcoming the focus on teaching/learning systems, including management elements, in an agile and secure manner, beyond the storage of documents.

Conflict of Interest

The authors declare that they have no conflict of interest.

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