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Model for assessing the maturity level of digital transformation in higher education institutions: a theoretical-methodological approach

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In these times of increasing digitization and process automation, digital transformation (DT) has become a determining factor for continuous improvement and competitiveness in organizations in all areas. In the context of higher education institutions (HEIs), DT plays a fundamental role in the evolution of teaching and learning, as well as in the administrative and operational management of universities, where the use of digital tools and strategies allows greater accessibility and flexibility in education, facilitating innovation, collaboration, and knowledge generation in globalized environments. The objective of this research was to develop a theoretical-methodological framework (TMF) that allowed the creation of a model to determine the level of maturity of DT in HEIs, for which a qualitative research methodology was used, based on grounded theory, with eight phases: literature review, interviews with managers and administrators, content analysis of the interviews, definition of dimensions, definition of components, definition of actors, creation of the practical model, and determination of maturity levels. This methodology allowed the construction of a digital maturity model integrated with eight dimensions, based on the main organizational processes in higher education, with four key components of DT and four relevant actors of the university system, thus structuring a framework that allows analyzing and evaluating the state of DT in the various institutions and thus improving the quality and efficiency of their processes in the current digital era.

KEYWORDS

maturity level, organizational processes, digital transformation, higher education institutions, theoretical-methodological framework

1 Introduction

Since the 1800s, the world has been subject to a gradual technological transformation, known as the industrial revolution. Each industrial revolution had its own characteristics and has generated great advances for humanity, currently reaching a digital world known as Industry 4.0, whose characteristic is an innovative range of technologies, increasing its impact on the creation of both agile and flexible processes and innovative business models in organizations. This has caused some industries to undergo drastic changes as a

result of the introduction of added value to products and services, thanks to technological applications. This industrial transition is aimed at achieving digitalization by creating a virtual world through the integration of the physical, digital, and biological (Mian et al., 2020; Rodriguez-Abitia and Bribiesca-Correa, 2021).

In recent years, higher education has undergone a profound process of digitalization-oriented adaptation, in which information and communication technologies (ICT) have played an important role. This has led to the emergence of new forms of teaching–learning, which must be aligned to a digital transformation (DT), which according to Vial (2019) is a process in which digital technologies generate disruptions that drive strategic responses by organizations, seeking to modify their value creation strategies while managing structural changes and organizational barriers that affect the positive and negative outcomes of this process.

The circumstances arising from the COVID-19 pandemic generated urgent and immediate demands for higher education institutions (HEIs) globally, forcing the accelerated adoption of online learning. This transition took place through the intensive use of digital educational platforms allowing a rapid and unplanned transition from face-to-face to virtual education. In addition, the virtualization of some administrative processes due to the introduction of telework modalities poses short-term challenges in DT to address health emergencies (Gaete-Quezada, 2023). According to Díaz-Garcia et al. (2023), ICTs are the real engine that drives organizations toward new forms of leadership and management, so they must transform digitally to survive in this new context, in the case of HEIs, their activity in this transformation will influence the development of human capital and talent. Therefore, DT will involve changes in both individuals and organizations.

DT is, above all, a process carried out by people for people. Its success depends to a large extent on the ability to understand and adequately measure the needs of the client (or citizen, in the case of public sector agencies), as well as on the level of preparation and organization of the team responsible for carrying it out. While there are many reasons why organizations undertake DT, the most common reasons are linked to the search for competitive advantage and the need to ensure their survival in a constantly changing environment. The new paradigms derived from technological innovations lead to the DT of organizations, HEIs cannot ignore these changes, which affect them like any other organization, but above all because of their activity: to train professionals who need to learn to manage and lead organizations in this new information society. Unlike other organizations, HEIs face a special challenge: on the one hand, they must transform themselves, incorporating the advantages offered by new technologies that allow them to develop advantages over their competitors and, on the other hand, they are responsible for training professionals who will be the future managers of their own organizations in this new environment.

DT is an essential process for HEIs to remain competitive and relevant in the current context, characterized by rapid technological advances and changing educational needs. Despite its importance, many universities lack a standardized and systematic framework for assessing their level of digital maturity. This lack of a clear model prevents accurate assessment and effective implementation of DT strategies, resulting in fragmented and inefficient efforts. Consequently, there is an urgent need to develop a comprehensive model that allows HEIs to diagnose their level of digital maturity and systematically guide their transformation processes. In addition, the literature on DT maturity levels and challenges, specifically in the area of higher education, is still limited. Despite the increase in DT in higher education, especially after COVID-19, there remains a significant gap in terms of comprehensive empirical studies that address digital maturity as a basis for planning and managing these change processes.

Given the transcendence of higher education in the information and knowledge society, it is considered that this study derives not only from the fundamental role that higher education has in the training of professionals but also from the key role that DT has in organizational processes, a fact that became more evident during the COVID-19 pandemic.

This research aims to propose a theoretical-methodological framework (MTM) for the creation of a model to assess the levels of DT maturity in HEIs through a comprehensive methodology, which will allow the integration of emerging technologies, the improvement of educational processes through digital tools, and the adaptation to the demands of the current digital environment.

Therefore, the research questions were as follows: What are the existing models of digital maturity and DT applicable in the context of HEIs, and what are the dimensions, components, and key actors that affect digital maturity in HEIs?

2 Contextualization of DT in HEIs

2.1 Digital transformation

DT drives a process of organizational change by facilitating the application and implementation of ICT. However, despite its importance, there is a gap between the demand and the availability of knowledge to carry out this transformation, where data analysis skills are essential in this process, which will allow organizations to be more competitive and ensure their survival. This transformation represents an objective process capable of responding to disruption in critical functions and changing environments of organizations (Luna and Breternitz, 2021).

According to Senja et al. (2025), this phenomenon encompasses the profound restructuring of administrative and operational processes, fundamentally modifying how organizations create and deliver value to their different stakeholders; this redefinition operates not only at a technological level but also at a cultural and structural level, promoting greater efficiency, flexibility, and responsiveness to changing environments.

Hovorka and Mueller (2025) argue that DT is not just the adoption of technological tools, but it involves a process of change in the nature and functioning of organizations; in its essence, this phenomenon encompasses a complete reconfiguration of business models, operating structures, and relationships with the environment through the strategic integration of digital technologies, proposing that the true outcome of DT is a state where digital technologies become an inherent and unnoticed part of organizational processes.

There are several reasons why organizations undergo DT; however, the primary reasons are related to issues of competitive advantage and survival. In other industries, such as education, four

elements are driving DT: customer experience, competitiveness, profitability, and agility (Marks and Al-Ali, 2022).

2.2 DT in HEIs

DT represents one of the most significant paradigm shifts faced by HEIs in the current context; this phenomenon goes beyond the incorporation of technologies, i.e., it implies a review and continuous improvement of processes, organizational cultures, and educational models.

The new paradigms derived from technological innovations lead to the DT of organizations. HEIs cannot ignore these changes, which affect them like any other organization, but especially because of their activity: to train professionals who need to learn to manage and lead organizations in this new information society. Therefore, it is necessary to implement technological innovations according to the needs, establish appropriate channels to communicate the process, and transform the current traditional culture into a digital one. Data-driven decision-making and the development of a participative leadership style will enable the organization to adapt to changes over time (Prasetyaningtyas et al., 2023).

DT is not only a general development trend, but it also helps to change the traditional d to a new active teaching method that helps students to be active and creative by participating in the learning process. The implementation of DT not only creates an intelligent educational model, making learning and knowledge absorption simpler and easier for students but also creates favorable conditions for knowledge transmission and develops students' abilities (Al Husseiny, 2023).

In the research of Afaishat et al. (2022), a study was conducted on 10 Jordanian universities to investigate the effect of strategic capabilities taking into account Artificial Intelligence (AI) and blockchain, the descriptive analytical approach was used for the results, determining that AI should be integrated into the business process to improve DT efficiently and effectively.

Digitalization in the university establishes mandatory rules (standards) for the creation and operation of digital technologies, which act as institutional limitations to almost all the proposed mechanisms and instruments of university institutional autonomy, including the university funding mechanism.

The incessant changes in technology generate new products and services, presenting multiple opportunities for the complex educational environment. Consequently, HEIs must be attentive to these changes to ensure that students have the knowledge and skills necessary to respond to the demands of the work environment (Farias-Gaytan et al., 2023).

DT is oriented to the improvement of organizational processes and the construction of new competencies and models through digital technologies in a deep and strategic way. It refers to an organizational change made through the application of digital technologies and business models to improve the operational performance of the organization. It is important to consider not only the fundamental role that higher education plays in the formation of future leaders, workers, and citizens, but also the key role that DT plays in today's knowledge economy, which became more evident after the COVID-19 pandemic.

2.3 DT technologies and tools in HEI

DT in HEIs transcends technological incorporation, becoming a multidimensional strategic process. Several studies highlight how HEIs are implementing customer relationship management (CRM) systems to improve student engagement and institutional efficiency, observing an evolution from approaches focused on service quality to advanced strategies driven by AI and social network analysis (Shalihati et al., 2025). Recent research emphasizes the need to assess student readiness for this transformation, identifying critical factors such as student characteristics, technological understanding, and organizational aspects that directly affect their ability to adapt to the digital environment (Greco et al., 2024). In parallel, emerging technologies such as blockchain and AI are renewing higher education models through smart contracts that foster collaborative work and generate more reliable information chains, preparing a generation ready to address complex problems from sustainable perspectives (de Bem Machado et al., 2024).

Although digitalization improves institutional productivity and competitiveness, maximizing the potential of emerging technologies requires visionary leadership and organizational agility. Studies on university digital maturity indicate that only one in four institutions has coherent digital strategies, while 56% implement isolated initiatives without integration into strategic plans (Bond et al., 2021). Innovative experiences such as the incorporation of drones in architecture programs demonstrate how these technologies enhance transversal competencies while increasing student motivation and optimizing spatial analysis processes (Rábago and Portuguez-Castro, 2023).

Finally, prospective research places the teacher as the central protagonist of this transformation, highlighting his or her role in the integration of emerging technologies through educational innovation processes, despite infrastructural obstacles and persistent technological inequalities in academic contexts (Pinto et al., 2023).

3 Methodology

This research adopts a qualitative methodological approach based on Grounded Theory (Díaz et al., 2023) due to its ability to generate a conceptual model from the systematic analysis of empirical data. Since this study seeks to develop an MTM to assess the maturity level of DT in HEIs, the Grounded Theory allows for identifying patterns, dimensions, components, actors, and emerging relationships directly from the information collected, without starting from predefined hypotheses. Through literature review and interviews with managers and those responsible for DT, data were collected and analyzed in this research. This approach ensures that the resulting model accurately reflects the organizational and educational reality of universities, providing

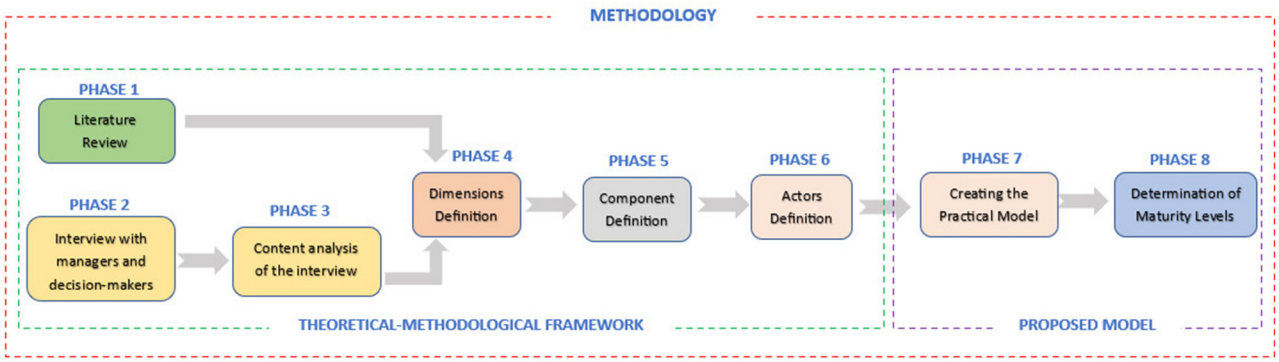

FIGURE 1
Applied research methodology.

a solid framework for decision-making and implementation of digitization strategies in academia.

This proposal consists of eight phases for the development of an MTM to build a model to measure the level of DT maturity in HEIs and answer the research questions posed. The phases are described in Figure 1, which includes both the construction of the MTM and the practical model.

3.1 Phase 1: literature review

A detailed exploration of the relevant literature on the conceptual foundations of DT was carried out to address the first research question: *What are the existing models of digital maturity and DT applicable in the context of HEIs?* This review included academic articles, Peruvian government policies on digital transformation, and international methodologies and models for evaluating or measuring digitalization and DT. Additionally, the second research question was addressed: *What are the dimensions, components, and key actors that influence digital maturity in HEIs?* This comprehensive review enabled the identification of the main dimensions, components, and actors that form the basis of the MTM and support the development of the proposed model.

The review process was conducted taking into consideration the following: (1) identification of articles using specific keywords or phrases, (2) filtering articles based on their abstracts, and (3) relevance and accessibility analysis.

In this literature review process, 127 open-access full-text articles published between 2015 and 2024 were obtained from the Scopus database, considering only research and conference articles. These articles were filtered and analyzed, with 36 articles selected for final review in this study, summarized in the literature review section.

3.2 Phase 2: interview with directors and those responsible for academic and administrative management

For the collection of qualitative information, a semi-structured interview was applied, using a purposive sampling based on criteria of accessibility and functional representativeness. Seven key informants belonging to a faculty of a Peruvian public university with direct experience in academic, research, and administrative processes related to DT were selected.

One of the university's faculties was taken as a pilot study unit, taking into account that, organizationally, all the faculties of the institution share a similar management structure, which makes it possible to consider the findings as indicative of the general functioning of the institutional processes.

The selected participants are as follows: a dean, three directors of professional schools, a head of a research unit, a head of a reading room, and a head of an administrative office. This composition made it possible to obtain a comprehensive view of different levels of decision-making. The inclusion criteria considered were as follows: (a) having an active role in institutional management, (b) direct knowledge of the digital processes in their area, and (c) voluntary willingness to participate in semi-structured interviews. The selection sought to ensure the variety of institutional perspectives relevant to the objective of this study.

The same interview script was applied to all participants, which allowed for consistency in data collection and facilitated a comparative analysis between different units or roles within the university. The main objective of these interviews was to explore the degree of knowledge, perceptions, and disposition of the members of the university community regarding DT, as well as to identify the priority processes for its digitization, the use of technologies, information management, the actors involved, and the critical factors for a successful implementation of DT.

This information is key to proposing viable and contextualized strategies that promote a real DT in the institution.

3.3 Phase 3: content analysis of the interviews

A qualitative component was incorporated to complement and deepen the understanding of the literature reviewed. For this purpose, semi-structured interviews were conducted with the heads of the main academic, administrative, and technological areas of an HEI, selected intentionally because of their direct link to the strategic processes related to DT.

The interviews were conducted in Spanish and analyzed under the grounded theory approach, allowing the categories to emerge directly from the data. The responses were transcribed with free web tools and subsequently analyzed using ATLAS.ti software, following the coding approach described in Section 4.1.3.

The process included three phases: open coding (identification of key concepts), axial coding (grouping and relationship between categories), and selective coding (integration of central categories). This approach facilitated the organization of the content around dimensions relevant to DT in HEIs. The analysis was performed by two researchers independently, using ATLAS.ti software. This procedure made it possible to refine the categories and strengthen the validity of the qualitative analysis.

As part of the qualitative analysis, a coding frequency matrix and a word cloud were developed to visualize the most recurrent terms in the discourse of the interviewees. In addition, an analysis of representative verbatims (textual phrases highlighted by the participants) was carried out to allow an in-depth interpretation of the perceptions, experiences, and barriers associated with DT. These fragments were categorized and discussed in an analytical table, enriching the understanding of the phenomenon studied from the direct voice of the institutional actors.

3.4 Phase 4: definition of the dimensions of the proposed MTM

A general theoretical foundation of the whole model was made, followed by a theoretical foundation of each of the dimensions, supporting the reason for each of them. For this purpose, the following were used: (1) articles by various authors on DT processes in HEIs, (2) Peruvian University Law No. 30220, to have a broad understanding of the processes in higher education institutions, (3) quality assurance in higher education, implies complying with the basic quality conditions (BQCs) established by law in an HEI where the institution must guarantee a minimum acceptable level of educational quality, ensuring that its programs, services, infrastructure, and management are oriented to offer relevant and effective academic training with public value, and (4) interviews with managers and those responsible for academic and administrative management.

Based on the above, this research proposed eight dimensions of the MTM: "socio-cultural," "teaching–learning," "academic management," "administrative management," "research and innovation," "digital governance," "institutional image and digital marketing," and "university extension." The dimension "university extension" was added since it allows for establishing the relationship between education, government, and business in DT.

3.5 Phase 5: definition of the components of the proposed MTM

The literature review allowed identifying the theories, methodologies, and models of DT, proposing for this work four components, such as "digital technology," "person and digital culture," "digital processes," and "data governance," which were supported through information searches in indexed databases.

3.6 Phase 6: definition of stakeholders of the proposed MTM

To define the stakeholders, various actors were identified, such as teachers, managers, students, clients, services, educators, researchers, institutions, government agencies, university personnel, and the organization.

Finally, the research proposed four relevant actors in the proposed model: "student," the source of the academic processes; "teacher," the actor immersed in the university processes; "administrative," the actor that supports the different processes; and the "manager," who manages all the processes.

3.7 Phase 7: creation of the DT model

Based on the MTM developed, which defined the key dimensions and components of DT for HEIs, as well as the relevant actors involved in the process, the model was built to assess the level of maturity of digital transformation in higher education institutions.

3.8 Phase 8: determination of DT maturity levels

Based on the analysis of the literature review, the maturity levels proposed by various authors were found: first, a general review was carried out; then, the review was carried out at the HEI level. Finally, three maturity levels were established: *beginning, in process, and continuous improvement*.

4 Results

The MTM developed to build a DT maturity model for HEIs consists of eight dimensions, based on the main organizational processes in higher education: four components, which are based on the key components of DT, and the four relevant actors in the university system.

The determination of the MTM is based on the methodology developed. First, an exhaustive review of the literature from various sources was carried out to develop a proposal that integrates scientific research on DT applied to higher education.

Second, the proposal was complemented with the application of interviews with the directors and those responsible for the academic and administrative management of a university, where the content analysis of their answers allowed categorizing the information gathered and supporting the MTM developed.

4.1 Phase 1: literature review

4.1.1 DT models and frameworks

The analysis of DT models and conceptual frameworks is essential to support the design of a model for evaluating the level of digital maturity in HEIs. The aim is to identify theoretical and methodological references that provide structural elements, significant dimensions, and applicable maturity levels, either from proposals designed specifically for the educational environment or from other approaches that contribute to the university context.

Although there are numerous models of DT in the business environment, it is scarce in the higher education sector. Therefore, this section includes both educational proposals and models from consulting firms and technology companies that, although developed for broader organizational contexts, integrate relevant elements that could be adapted to the university environment, recognizing their potential for adaptation, but also critically questioning their limitations from a pedagogical point of view.

The digital capability maturity model (Aguiar et al., 2019) is based on ISO/IEC 330xx standards, it allows us to assess the current situation of an organization in its DT process. It provides a generic but useful structure to identify gaps and define improvement paths in the DT process of a university. This model emphasizes a vision of organizational processes and capabilities that, although valuable, need to be reinterpreted from educational logics, focused on comprehensive training and meaningful learning.

From the private sector, proposals such as those of Boston Consulting Group (Puckett et al., 2021) propose cloud infrastructure, access to data, digital tools, business processes, machine learning, and AI as elements. On the other hand, models such as those of Deloitte in Peru (Nivel de madurez | Deloitte Perú, 2023), Virtus (Índice de Madurez Digital Virtus, 2023), or Multiplica (Gaffoglio, 2021) have been developed for business contexts but offer maturity taxonomies and organizational components (strategy, processes, technology, culture, data, etc.) that can be adapted to universities interested in assessing their institutional transformation from a holistic perspective. The same is true of the MIT (Massachusetts Institute of Technology) model, which, although based on private companies, introduces a useful typology by distinguishing between digital intensity and change management intensity (Chanias and Hess, 2016). This assumption omits the multiple controversies and risks associated with such technologies, including algorithmic biases, the privacy of personal data (especially those of students and teachers), and the ethical implications of automation in pedagogical decision-making.

KPMG's business framework is specialized in consumer and HEI DT based, called "a model for digital transformation in universities," and has six organizational elements: customers, channels, business strategy, core business practices, advanced data and analytics, and enabling business practices. Similarly, Microsoft presents a higher education DT model, taking into account four dimensions: student achievement, teaching and learning, academic research, and a safe and connected campus. In addition, Google's model of education transformation classifies seven elements of transformation: vision, learning, culture, technology, professional development, financing and sustainability, and community engagement; the framework also proposes that teachers should be offered effective professional development and continuous training to help them in skills and techniques to be able to meet the requirements of their students (Alenezi, 2021).

These models proposed by KPMG, Microsoft, and Google, while providing valuable structures, have certain limitations. First, their corporate approach may not be adequately adapted to the regulatory and socio-cultural contexts of public HEIs, especially in developing countries. In addition, they tend to focus on technological and functional aspects, leaving aside strategic dimensions such as institutional governance and active student participation. There is also an absence of clear mechanisms to measure the level of digital maturity, through diagnostic or monitoring tools. These shortcomings limit their usefulness for institutions that require a comprehensive, gradual, and contextualized DT.

In Zaoui and Souissi (2018), an ontology-based model is presented to represent knowledge associated with DT. The authors of this study classify knowledge domains into nine dimensions: structural, informational, environmental, safety, quality, financial, cultural, innovation, and participation. It is a conceptually robust model that contemplates very diverse perspectives drawn from the literature as of 2018. However, although it covers a broad spectrum of organizational and technological factors, it is necessary to complement this approach with a critical pedagogical perspective. This would help avoid decision-making around DT in HEIs being guided exclusively by technical or administrative logics, often influenced by business interests. Incorporating this educational perspective would help to ensure that the DT also responds to the educational, ethical, and humanistic principles that should guide university work.

In the case of Bettayeb and Al Marri (2021), a research framework designed to assess the relevant factors of teamwork within DT projects in a university in the Arab Emirates, Dubai, is presented, where a research framework was proposed for the identification of key factors of teamwork, conducted with the quantitative method by applying a questionnaire to all staff working in DT in the institution, which is a guide for all project leaders, as it will help organizations to manage, develop, and maintain team performance and prevent any human or project failures. This approach considers the role of leadership, change management, and the participation of key stakeholders—essential elements for an effective implementation of transformation in HEIs.

For the researchers Benavides et al. (2020), a literature review of 19 articles between 1980 and 2019 summarizes the processes of HEIs that have been intervened by DT, identifying 11 dimensions: teaching dimension, infrastructure, curriculum, administration, research, human resources, extension, DT governance, information, marketing, and business processes—with the teaching dimension being the most addressed, followed by infrastructure and curriculum. This review enabled the development of a validated instrument (Castro et al., 2022).

Other dimensions are those found by Petkovic et al. (2014) and detailed through a maturity model by Marks and Al-Ali (2022), which they call the mega processes in HEIs: the learning and teaching process, the research process, the enabling process, and the planning and governance process.

In the work of Đurek (2017) and Đurek et al. (2019), a maturity model for DT in HEIs is first introduced, followed by the proposal of an instrument based on seven dimensions: leadership; planning and management; quality assurance; scientific research work; technology transfer and services to society; teaching–learning; ICT culture; and finally, ICT infrastructure and resources.

Poletaikin et al. (2021) propose five dimensions to assess digital maturity in educational organizations: technical and technological, cognitive, social, psychological, and spiritual aspects. Similarly, Shevtsova et al. (2022), in their digital maturity model, establishes nine dimensions: organizational culture, competencies, processes, products, models, data, infrastructure and tools, global digital environment, and personality, which can be applied to any type of organization, according to the authors.

In all the models reviewed, there is a general coincidence in the substantial components of DT: technology, data, processes, and people. The levels of digital maturity range from three to six stages, depending on the author or institution. In the specific context of HEIs, the role of the teacher stands out as the main actor in the DT processes since his or her active participation is decisive for an effective and contextualized implementation.

We are currently immersed in the scope of Industry 4.0 and Society 5.0, and taking into account that HEIs are also organizations, it becomes necessary that the model must be properly adapted by providing them with the appropriate contextualization. They should be based on an integrated model of DT, considering the application of an instrument to assess their status and measure their level of maturity, which provides them with a comprehensive view of their position on the road to DT, as well as the necessary steps to be taken to take better advantage of the smart use of ICTs, taking into consideration the opportunities and challenges of a dynamic competitive environment, proposing a roadmap toward DT to help them plan relevant actions to gradually scale to higher levels of maturity and IT leverage, thus achieving their organizational objectives (Rodriguez-Abitia and Bribiesca-Correa, 2021).

The review evidences the need for a specific model that evaluates DT maturity in HEIs from an integral approach, which not only gathers good practices of adapted business models but also incorporates pedagogical, ethical, and contextual principles. Only in this way will it be possible to develop a truly meaningful and sustainable DT, at the service of educational purposes and the welfare of the entire university community.

4.1.2 DT regulations in Peru

In Peru, the first advances in DT were made in 2010 with the Supreme Decree No. 090-2010-PCM, which approved the Consolidated Progress in Reform and the Strategy for Modernization of State Management, the main objective being the transformation of the Peruvian State. The overall goal is administrative simplification, which is considered in the DT Regulation (Decreto Supremo No. 090-2010-PCM, 2010).

Following the same route, in 2017, the Supreme Decree that expands the information for the progressive implementation of interoperability for the benefit of the citizens was approved. According to Legislative Decree No. 1246, on May 8, 2018, the Digital Government Committee is created, as well as its functions, scope, and management and planning guidelines in Digital Government are established, in 2019 through the Resolution of the Secretariat of Digital Government No. 003-2019-PCM/SEGDI provide for the creation of the Laboratory of Government and Digital Transformation of the State in the Presidency of the Council of Ministers (Decreto Legislativo No. 1246, 2016).

In 2020, with Emergency Decree No. 007-2020, the measures that are necessary to ensure the confidence of people in their interaction with digital services provided by public entities and private sector organizations in the national territory were established; in 2021, with Supreme Decree No. 157-2021-PCM, the Regulation of Emergency Decree No. 006-2020, which creates the National System of Digital Transformation, was approved; finally, on September 24, 2022, with the Resolution of the Secretariat of Government and DT No. 002-2022-PCM/SGTD, the Guide for the use and integration of the National Digital Signature Platform in the entities of the Public Administration was approved (Decreto de Urgencia No. 007-2020, 2020).

Through Supreme Decree 157-2021-PCM, the term "digital citizenship" is defined as the ability of people to develop at a comprehensive level in the digital environment. This involves the development of digital skills, carrying out procedures with public entities and private sector organizations, performing financial transactions, selling or buying products or services through e-commerce, performing entertainment activities, communicating through various platforms or applications, and searching and obtaining information on the Internet. Finally, on July 28, 2023, the Government approved the National Digital Transformation Policy 2030 (PNTD); this public policy instrument determines the guidelines, objectives, standards, actions, services, indicators, activities, goals, and responsible parties to achieve the country's DT (Política Nacional de Transformación Digital, 2023).

4.1.3 DT analysis categories

DT in HEIs has required the identification and application of several *key factors* for a successful implementation. Thus, Sułkowski et al. (2024) highlight that the transition to learning platforms, such as Moodle or Blackboard, was essential to ensure the educational processes, being still limiting, teacher training and resistance to change; on the other hand, Morawska and Carayannis (2024) identify the need to integrate emerging technologies, such as AI and machine learning, to optimize teaching and institutional management. Similarly, Zhu et al. (2024) highlight that among the key elements is university digital leadership, where institutional leaders must foster an environment of innovation and direct the adoption of technologies.

DT has had a significant impact on the academic and administrative *processes* of HEIs, promoting greater efficiency, transparency, and sustainability. This is considered by Jayakumar and Prabakar (2024) when they indicate that the automation of processes has made it possible to optimize resource management, improve decision-making, and reduce operating costs. In particular, the digitization of document management has facilitated the reduction of paper use and promoted sustainable practices

in universities (Herrera-Granda et al., 2024; Bravo et al., 2025). Similarly, the use of technological platforms and administration of academic services has demonstrated an improvement in operational efficiency, reducing waiting times and minimizing administrative errors (Marienfeldt et al., 2024).

DT has allowed university processes to be successfully *digitized*, enabling efficient and optimal academic and administrative management. According to Hartong (2024), one of the priority processes was the digitization of data infrastructures that facilitated interoperability between educational and governmental systems. Carvalhais and Azevedo (2024) found that the digitization of teacher training has been key to integrating educational technologies, with self-assessment tools and learning platforms for the development of digital competencies. On the other hand, López et al. (2024) found as a priority process the ethical management of research, for which a digital platform was implemented, improving traceability and transparency in the evaluation processes, and Acuna et al. (2024) identified that in a university it was prioritized to develop a digital maturity model that allows the optimization of the management of academic and administrative information to consolidate its DT.

DT in higher education is being driven by the adoption of *emerging technologies* such as AI, Blockchain, digital learning platforms, and data analytics tools. According to Sydorenko et al. (2024), digitization of educational infrastructures and open access has led to improved academic management and equality of education for all. Lu et al. (2024) and Sahin Kölemen (2024) point out that the implementation of systems with generative AI and intelligent learning platforms has revolutionized teaching, allowing personalization of learning and automation of teaching tasks. On the other hand, Zhao et al. (2024) found that tools with chatGPT and augmented reality models are facilitating interactive tutoring and student dropout prediction, allowing early intervention and better learning management. Similarly, the use of learning analytics and curriculum automation is optimizing educational planning, although there are still challenges with privacy and regulation of AI use in academic environments.

DT in HEIs involves a variety of strategic *actors* whose participation is fundamental for the success of proposals and initiatives. The literature indicates that university leadership plays an important role in defining digital strategies and allocating resources to ensure their effective implementation (Zhu et al., 2024). Similarly, faculty and administrative staff are key elements in the implementation of emerging technologies, but digital readiness should also be considered as a limiting factor (Chounta et al., 2024). Resistance to change within administrative and academic staff remains a major challenge, so alignment strategies are required for consistent DT implementation (Hoblos et al., 2024). In addition, students, as the primary stakeholders and users of these technologies, must be considered in digital planning to ensure their engagement and effective participation in digitized learning environments (Gutu et al., 2024).

The adoption of multiple communication channels has been driven by DT in HEIs to optimize academic and administrative management. Díaz García (2024) and Volk et al. (2025) found that the incorporation of institutional social networks, learning management platforms, and internal messaging systems has facilitated interaction between students, faculty, and external stakeholders. In addition, Strauss et al. (2024) argue that digitization has enabled greater diversification of communication within universities, promoting their decentralization through autonomous laboratories and research centers. In the field of research, Belli and Ponsot (2022) point out that the expansion of digital scientific networks and collaborative tools in the cloud has significantly improved access to and dissemination of knowledge.

Finally, the large amounts of data and information generated by institutions and the intelligence derived from them, remain isolated within the institutions (Ranathunga et al., 2024), where, the protection and security of the data in HEIs are fundamental when implementing DT in their academic and administrative processes (Xue, 2024); similarly, data and information processing has become the most important competencies of the future workforce for the implementation of digital technologies in higher education. This data and information managed through the application of emerging technologies in HEIs' DT, such as cloud computing, Internet of Things (IoT), and AI, provides unprecedented convenience and connectivity, redefining the way such data and devices are interacted with (Nacer and Abdmeziem, 2024).

4.2 Phase 2: interview with managers and those in charge of academic and administrative management

This phase consisted of the collection of qualitative information through semi-structured interviews with the strategic actors of the faculty chosen as the pilot study unit: director of the research unit, director of the academic department, director of the administration unit, directors of professional schools, and heads of technology areas. This strategy of selecting the actors to be interviewed made it possible to obtain a contextual and operational approach to the institutional processes that could be digitally transformed, as well as to maintain a balance between academic, administrative, and technological roles.

The interviews were conducted in person, over a period of 15 days, following a structured guide around key dimensions such as current processes, use of technologies, data management, communication channels, actors involved, and critical factors for DT. The sessions were audio-recorded with the consent of the participants and later transcribed for analysis.

This phase allowed the collection of valuable qualitative information that served as the basis for the content analysis conducted in the next phase of this study.

4.3 Phase 3: content analysis of the interviews

For the qualitative analysis of the interviews, categories of analysis were defined, based on a review of the literature on DT in HEIs, defined in phase 1 of the methodology, specifically in Section

4.1.3, and a verbatim analysis of the interviews conducted with key HEI personnel was also carried out.

Seven categories were identified: (1) key factors to be taken into account, (2) processes in their area, (3) digitally transformed processes, (4) technologies to be applied in the processes, (5) actors involved in the processes, (6) communication channels, and (7) information or data handled in their activities. These categories guided the formulation of the interview questions and allowed the systematic coding of the responses in the Atlas.ti software.

These interviews were transcribed from audio to text, using a free web application such as Happyscribe (https://www.happyscribe.com).

Table 1 summarizes the analysis of the interviews conducted, considering the categories defined above. Verbatim excerpts from the main interviews have been obtained to support the interpretation of the findings, providing a structured view of the challenges and opportunities in the university's DT.

This analysis allowed us to identify a generally favorable disposition toward DT, although nuanced by structural, technological, and cultural barriers. The diversity of perspectives collected invites us to propose differentiated strategies, based on a shared institutional diagnosis and focused on capacity building, process improvement, and effective articulation among actors.

TABLE 1 Verbatims analysis.

Code/ category	Description	Evidence (verbatim)	Interpretation
C1—Key factors to consider	Lack of infrastructure and training in technology.	"I think on the one hand it is the infrastructure part [...] staff training." (Professional Program Director). "The authorities I think management is fundamental [...]" (Head of Research Unit). "Socialization of the objectives [...] digital tools." (Professional Program Director). "We are not prepared, neither teachers nor administrative." (Dean).	The testimonies suggest that the lack of training and the limited preparation of technical and teaching staff are factors recurrently mentioned as barriers to DT. Although not everyone elaborates on this, there is a common need to improve digital competencies at all levels.
C2—Processes in your area	Lack of automation in the issuance of student documents and teacher monitoring.	"We want to take the model of what FACEAC is [...] we do everything manually." (Head of Administration Office). "As a school director I have never had access to see in real time [...]" (Professional Program Director). "Attend to student demand regarding the baccalaureate seminar." (Professional Program Director). "Modernize laboratories after 40 years." (Dean).	The description of the processes reveals a variety of services offered, some of which are still executed manually. This diversity shows a wide field for digital improvement, although the testimonies do not always agree on which processes are a priority. There seems to be a trend toward the systematization of student care flows.
C3—Digitally transformed processes	Digitization of enrollment and use of research platforms.	"Before the registration was quite tedious [...] now it is more straightforward." (Head of Research Unit). "We work with the Selgestiun and Turnitin platform." (Head of Research Unit). "The Selgestiun platform collapses with duplicates." (Secretary Research Unit). "There are very clear shortcomings that obstruct progress." (Director of Academic Departments).	The testimonies show partial progress in digitization, such as in enrollment and research. However, technical limitations and lack of integration between platforms are also identified. This indicates that although there are efforts to digitize, important challenges persist in terms of the efficiency and usability of the systems.
C4—Technologies to be applied in the processes	Artificial Intelligence, Big Data, and management systems.	"Artificial intelligence is in vogue [...]" (Dean Secretary). "It would be interesting to apply Big Data." (Dean). "Learning management system [...] online education." (Professional Program Director). "Turnitin and the SIBI system." (Head of Research Unit).	Several interviewees mention technologies such as Turnitin or virtual platforms. These references suggest an awareness of and openness to new tools, although there is no evidence of standardized or systematic implementation. The reference to AI seems to be more linked to an aspiration than to a concrete application.
C5—Stakeholders involved in the processes	Participation of administrative offices, teachers, students, and authorities.	"We have to involve the budget office, planning [...]" (Head of Administration Office). "The main protagonists are the students." (Head of the Reading Room). "Social responsibility, research, academic services are involved." (Professional Program Director).	The responses show the participation of diverse actors, including administrators, teachers, students, and authorities. This diversity could represent both a strength and a weakness, especially if there is not adequate articulation among these groups. The general perception indicates that inter-institutional collaboration can still be strengthened.
C6—Communication channels	Predominance of email and informal communication.	"Communication is via email and sometimes face-to-face." (Professional Program Director). "We lack a document tracking system [...]" (Secretary Dean's Office). "Email and personal visits." (Professional Program Director).	Testimonials indicate that email is the most used channel, followed by face-to-face interactions and WhatsApp. However, difficulties in following up and responding to requests are also mentioned. This suggests that communication, although established, could benefit from greater systematization and digital follow-up.
C7—Information or data you use in your activities	Academic, budgetary, and research data management.	"I work with the dean on budget tracking and purchasing." (Head of Administration Office). "We handle research reports and publish them [...]" (Head of Research Unit).	Interviewees refer to data related to students, teachers, budgets, and research. Although some processes are digitized, others still rely on the use of physical documents or mail exchanges. This could limit the ability to analyze and trace information in real time.

	1: Entrevista... 18	2: Entrevista... 31	3: Entrevista_... 29	5: Entrevista_... 13	6: Entrevista_... 34	7: Entrevista_... 28	Totales
Actores que participan en el proceso 16	3	4	1	2	3	3	16
Canales de comunicación 16	1	3	6	2	3	1	16
Factores clave necesarios a tener en cuenta 12	3	1	1	1	3	3	12
Información o datos que maneje en sus actividades 27	4	6	9		7	1	27
Procesos de su área 21	3	6	4	2	4	2	21
Procesos transformados digitalmente 22	1	5	3	4	3	6	22
Tecnologías a aplicar en los procesos 29	2	4	2	1	9	11	29
Totales	17	29	26	12	32	27	143

FIGURE 2
Code-document analysis by Atlas.ti.

The code-document analysis or coding frequency matrix in Figure 2 shows the frequency with which the categories of analysis related to institutional DT were mentioned in each of the interviews, processed using ATLAS.ti software.

Among the most important findings, it was identified that the category "technologies to be applied in the processes" was the most recurrent, with a total of 29 codifications. This category had a high presence especially in interviews 6 and 7 (dark-colored cells), suggesting a sustained concern or interest in the identification and application of emerging technologies in institutional processes. Similarly, the category "information or data handled in its activities" reached 27 mentions, highlighting the relevance of data management in the operational dynamics of the areas interviewed.

On the other hand, categories such as "actors participating in the process" and "communication channels" were less frequent (16 mentions for each), which could be interpreted as a low visibility or a lack of clear articulation of these aspects in the discourse of the interviewees. Something similar occurred with the category "key factors necessary to take into account," which was mentioned 12 times, despite being fundamental to guarantee an effective implementation of DT processes.

These results enrich the findings of the literature review, providing a deeper and more contextualized view of the factors that affect the DT process in HEIs.

On the other hand, the word cloud (Figure 3) generated from the transcriptions of the interviews allows us to visualize the most frequently used terms in the participants' discourses. Concepts such as process, research, system, school, university, information, student, and transformation stand out. These words reflect the institutional focus of the interviewees, centered on the operability of academic and administrative processes, as well as on the implementation of technological systems linked to information management and research development. Similarly, terms such as service, library, faculty, area, and technologies reinforce the diversity of organizational units and functions addressed during the interviews.

This visualization complements the findings coded in ATLAS.ti, by showing coincidences with the categories analyzed and reinforcing the centrality of certain thematic axes within the DT process in the institution.

4.4 Phase 4: definition of the dimensions of the proposed MTM

The application of DT approaches to the domain of HEIs is an emerging field that has aroused interest in recent years and that due to the pandemic has taken greater interest due to the shortcomings found in the teaching–learning process, in university management, in the mastery of the digital competencies of the members of the university community, and in the technological support that was necessary to successfully deal with the health crisis by COVID-19.

From the literature review, it was possible to observe the different initiatives that exist on DT in HEIs. The approach used for the development of the proposed model is the application of an integral vision of the different organizational processes and actors that are part of the activity of HEIs in different contexts.

Specifically in Peru, according to III Informe Bienal sobre la Realidad Universitaria en el Perú (2022), the year 2021 saw the successful completion of the first institutional licensing, which marked the first milestone on the long road toward a university system oriented toward excellence in its activities, processes, and facilities. Institutional licensing is a process implemented by the National Superintendence of University Higher Education (SUNEDU) that evaluates whether Peruvian universities comply with BQCs established by law, to ensure that HEIs offer quality education, with adequate human resources, infrastructure, curricula, research mechanisms, and welfare services.

In addition, the Peruvian University Law No. 30220 defines the University as an academic community oriented to research and teaching, which provides humanistic, scientific, and technological training with a clear awareness of our country as a multicultural reality; it is evident that the processes involved in research and teaching are the fundamental pillars of higher education, in addition to the management of digital skills and soft skills.

FIGURE 3
Cloud of concepts obtained in the interviews and analyzed by Atlas.ti.

In Peru, with the creation of the National System of Evaluation, Accreditation, and Certification of Educational Quality (SINEACE) and the SUNEDU, public and private universities are evaluated and regulated to ensure that students have access to the necessary tools to achieve quality education.

Peruvian universities self-evaluate and request external evaluation with accreditations and certifications, which allow them to improve their academic and administrative processes. Thus, Supreme Decree No. 016 of MINEDU, which establishes the policy of quality assurance in higher education, defines quality as "the degree of adjustment between the actions that a university, academic program or career carried out to implement the guidelines contained in its mission and institutional purpose and the results achieved by these actions." Therefore, universities must take the necessary actions to reduce the gap between their mission and institutional purpose and the results of the same, where each academic and administrative process must be integrated and measured through indicators (Montenegro Ordoñez, 2020).

To identify the dimensions, the research was based, first, on studies that could identify the HEI processes that have been taken into account for DT; second, existing methodologies and models on DT and maturity levels; and third, the policies and regulations of this sector dictated by the bodies that regulate its activities and educational quality; in this case, the regulations in Peru have been taken into account as a case study and have been reflected in phase 1 of the methodology applied.

The theoretical basis of each proposed dimension is explained in the following paragraphs, specifying what is to be evaluated and its scope.

The Socio-Cultural dimension, regarding the social aspect, will allow the evaluation of the level of digitization of the integral sustainable plan (a long-term plan of social responsibility and environmental care) that the university has, through the appropriate use of technologies by all members of the university community, regulated by rules and regulations that ensure a positive impact on their skills and competencies and meeting sustainability objectives with society (Nunez Valdes et al., 2021); similarly, university social responsibility is analyzed in the fulfillment of the union between university, government, civil society, and private sector (Pernía et al., 2022).

As for the cultural aspect, it includes the commitment and participation of the members of the Institution both internally and with the community, in addition to the management of soft skills and digital competencies necessary for the use and management of organizational processes that lead us to a DT.

The Teaching–Learning dimension contemplates the evaluation of teaching methods, course design, learning strategies and materials, counseling and tutoring, as well as the evaluation of the entire teaching and learning process, where educational

innovation is also present (Ramírez-Montoya, 2020), along with the teaching resources. The level of maturity will determine the use of contemporary educational tools and methods with technology and digital innovation, allowing flexible learning spaces, oriented toward autonomy in a collaborative manner.

The purpose of the Academic Management dimension is to evaluate the facilities for the development and improvement of academic processes in terms of curricular planning and programming, articulation, execution, and evaluation of the teaching–learning processes. Under the DT approach, strategies for improving content through digital learning and the wider use of ICT technologies should be achieved in the ADP (Mikheev et al., 2021), updating the curriculum in line with technological advances and what the globalized market needs (Alenezi, 2021), access to updated and online student academic information, having digitized academic services that provide facilities and time savings, and the development of digital competencies of teachers and students (Zabolotska et al., 2021).

The Administrative Management dimension expresses the activities of planning, organization, direction, and control for the fulfillment of institutional objectives. From the DT perspective, the digitization of administrative services should be achieved by investing in the application of new technologies (Alenezi, 2021), alignment of technological advances in institutional policies, strategic plan, and a shared vision toward DT (Aditya et al., 2021a; Coral and Bernuy, 2022), access to real-time information on administrative processes for decision-making, improvement of processes to raise the productivity of human resources, having the necessary economic resources to invest in technological innovation proposals, and providing the necessary means to strengthen the digital competencies of administrative staff (Aditya et al., 2021b).

The Research and Innovation dimension aims to position the university as a reference in terms of scientific production and generation of entrepreneurship and innovation projects. To develop such activities focused on DT, participation in training courses, participation in research and innovation projects, scientific and academic publications, and use and access to indexed databases must be evidenced, in terms of innovation, applications in innovation events, generation of companies, and generation of patents.

The purpose of the Digital Government dimension is to evaluate the management of those responsible for the application of information technologies in the institution, taking into account the added value generated by the digitization of processes and services, computer systems, regulations, risk management plan, monitoring and control of procedures, as well as digital leadership, and the use of ICTs in the operation of the administrative and academic areas of the institution, contributing to transparency and raising the quality of services (OEA, 2009). The government proposes strategies that involve open data, and thus transparency, to identify the most important aspects and trends of new technologies (Toro-García et al., 2020).

The Institutional Image and Digital Marketing dimension, as pointed out by Gordillo et al. (2020), states that HEIs must develop processes and activities to attract students, seeking their loyalty and achieving their satisfaction as students. Similarly, Toledo and Martínez (2017) state that marketing as a component of the University's strategic planning should develop policies regarding actions to attract undergraduate and graduate students, both national and international, and promote the services offered to the external environment. Similarly, as pointed out by Regnault et al. (2018), the educational environments of higher education today have become increasingly competitive, where the institutional image is considered as the main element of influence in the choice of new students for an academic institution, as well as public perception in general.

Under this context and taking as a reference (Benavides et al., 2020), the dimension of Institutional Image and Digital Marketing in the context of DT aims to identify whether the educational processes are developed under technological platforms and how they influence the university experience. It also seeks to determine whether it has technological and digital means for activities to promote academic offerings, as well as the use of technological tools for the analysis of competition, all this seeking to have a model or set of digital marketing strategies based on ICT, which allow it to project a solid image and a positive impact on the community, as one of the best universities in the country.

The University Extension dimension is considered, together with research and teaching, in the context of university institutions, as one of the main functions and basic pillars on which a university model committed to society is built. In addition, university extension is a process that implies efficient communication with society, facing the various sectors of society with which it interacts and has a relationship. Parrón et al. (2021) express that university extension has the primary function of training well-trained and committed human talent with a good projection and community integration, as well as the development of extension programs designed for permanent dialogue with the community and with full knowledge of its main problems, becoming instruments of the necessary changes.

In this context, the DT will allow to enhance the systematization of the process of virtualization and digitalization of the university extension, which allows to offer effective responses to the socio-cultural needs of the university and social contexts, to develop the transfer of knowledge with the community, seeking to significantly influence the results and impacts that allow the development of communities.

4.5 Phase 5: definition of the components of the proposed MTM

In recent times, DT has gained much momentum; however, a review of the literature reveals that there is a wide range of views on it, resulting in a variety of interpretations and conceptualizations.

DT, in the view of Draheim et al. (2021), is perceived as the key enabler for increasing wealth and wellbeing by policy, media, and citizens alike. Similarly, Werner and Zamora (2018) will impact the success and demise of firms, old and new, in all sectors, of all sizes and in all geographies.

According to Alenezi (2021), HEIs have long been considered the center of creation and dissemination of knowledge, but nowadays access to information and knowledge no longer has the

physical limits of the cloisters of study and can be obtained in various ways in virtual spaces and through technologies such as virtual and augmented reality, learning videos, gamification, and Big Data.

Regarding Data Governance, Draheim (2021) points out that currently in all countries great efforts are being made in DT initiatives, and according to the UN E-Government Survey 2020, a lot of emphasis is being put on data, which makes sense, given the huge progress in Big Data and data science in the last decade. Su et al. (2022) refer that it is the prerequisite for data sharing in DT, considering that data have become a strategic resource that businesses and society pay attention to. Similarly, Lis et al. (2022) express that the strategic use of data is encouraged by promoting data-driven innovation, although it determines that the opportunities for the emergence of technological advances also depend on the characteristics of industries or organizational structures. Similarly, data governance improves the quality of an organization's data and links data assets with responsible organizations (Draheim, 2021; Hickey et al., 2021).

Data governance in higher education, according to Omar and Almaghthawi (2020), is fundamental in the digitization of its processes for DT, so it must be integrated with the strategies of the university to use the most appropriate digital technologies and have a functional team for these data governance tasks, developing a data audit, monitoring compliance with regulations, imparting information on data governance to all members of the institution, and conducting frequent evaluations of the plans and policies proposed and implemented, which would manage Big Data and ensure data quality to improve operational efficiency. Similarly, Chen and Liu (2022) consider university campus data as a subset of educational Big Data, obtained from data generated by teachers and students in university life, teaching, scientific research, management and service processes, as well as academic management, which will serve to generate a smart campus using emerging technologies, through a Big Data management platform, collecting existing data inside and outside the university and managed with a standardized and centralized data governance model.

Ljepava (2022) points out that DT led by disruptive technologies can help organizations address numerous challenges and deliver better customer value through innovative technologies in all areas of the business, such as AI, in decision-making throughout the stages of the marketing process in companies.

In higher education, according to Limani et al. (2019), institutions are preparing for the use of emerging digital technologies to be used in the teaching process, as well as in their administrative activities of communication—both internal and external—which allow the DT of their processes, considering among them, AI, cloud technologies, and the IoT. Along the same lines, Alenezi (2021) considers as disruptive technologies to be used in higher education the social web, blockchain, mobile technologies, augmented reality and virtual reality, and Big Data.

As Cserdi et al. (2022) point out the spread of digital culture is one of the greatest reprogramming of humanity, which will radically transform our economic, social, and cultural models, considering that half of the world's population still lacks access to the Internet in an era of DT.

For Shpak et al. (2022), digital culture is the basis of the corporate culture of organizations; in the case of the Ukrainian state employment service sector, the possession of relevant digital skills for employees is considered as a basic condition for the formation of a modern labor market.

Cultural transformation, as part of the DT, not only allows innovation in production processes but also in the provision of services such as education, seeking to generate positive experiences. As indicated by Espinosa-Vélez et al. (2022), it is the responsibility of HEI managers, through their strategies, to move toward a digital culture in which the entire educational community can interact, leaving aside the traditional structures applied to the management of students and the general public, where DT allows an agile relationship with the institution, optimizing resources and response times.

In the same line, education has a key role in meeting emerging demands, where educational institutions must generate policies for the comprehensive development of digital competencies. Digital culture emerges as a key factor in the DT process, as well as a cultural transformation model that leads to the digitization of their institutions. In addition, organizations that are able to efficiently transform into digital organizations will adjust to new socioeconomic situations and achieve competitive advantages (Laorach and Tuamsuk, 2022; López-Gracia et al., 2022).

DT in higher education has the emphasis placed on the implementation of innovative educational models, which are aimed at training specialists who have digital culture and digital competencies, which they can use in their professional activities, where the success of DT is strongly influenced by organizational culture, as well as transformational leadership and organizational commitment to provide adequate resources (Imbar et al., 2022; Leybert et al., 2022). The same approach is expressed by Jaico et al. (2019) pointing out that the mastery of IT tools by teachers and the application of technological solutions enable the digitalization and DT in higher education to be on track.

Digital technologies are immersed in all processes, being the backbone, and in all sectors, whether banking, infrastructure, or companies in general, where they are empowered through data. This raises the need to digitize documents and highlights innovation as a critical factor to boost DT in all sectors (Mayorga, 2022; Rummel et al., 2022).

As manifested by von der Heyde (2022), HEIs must drive opportunities and risks, as well as methods to guide digital changes. The leaders of the institution are responsible for defining agendas and responsibilities on everything that means "digital." The most prominent factors for its effect are as follows: how to cope with changes, the flexibility of staff deployment, new jobs, and roles, as well as the importance of soft skills. Also, Garcez et al. (2022) consider that DT in higher education has changed the means and mechanisms of knowledge acquisition, which means that it has changed the form of student–professor and teaching–learning interaction, where apart from the necessary soft skills, hard skills that allow achieving concrete and specific skills for a particular job are also important.

4.6 Phase 6: definition of stakeholders of the proposed MTM

The actors considered as managers and members of the university processes are as follows: the student (ES), the teachers (DO), the administrative (AD), and the directors (DI), taking into account the definitions established in the Peruvian University Law and applied to a global context.

Student (ES): A university student is a person who accesses higher education, through traditional or non-conventional routes, to train academically and professionally, integrating into a community oriented to learning and global development.

Teachers (DO): Those who teach in the country's universities, which implies the performance of their teaching, research, and social projection functions, permanent training, intellectual production, promotion of culture, creation and promotion of art, production of goods, provision of services, and others, in accordance with the principles and purposes of the university.

Administrative (AD): It is subject to the regime of public servants, and the university promotes and carries out specialization training courses on their behalf.

Director (DI): This is considered to be a teacher who has assumed a position in the organizational structure of the university for academic management, in addition to

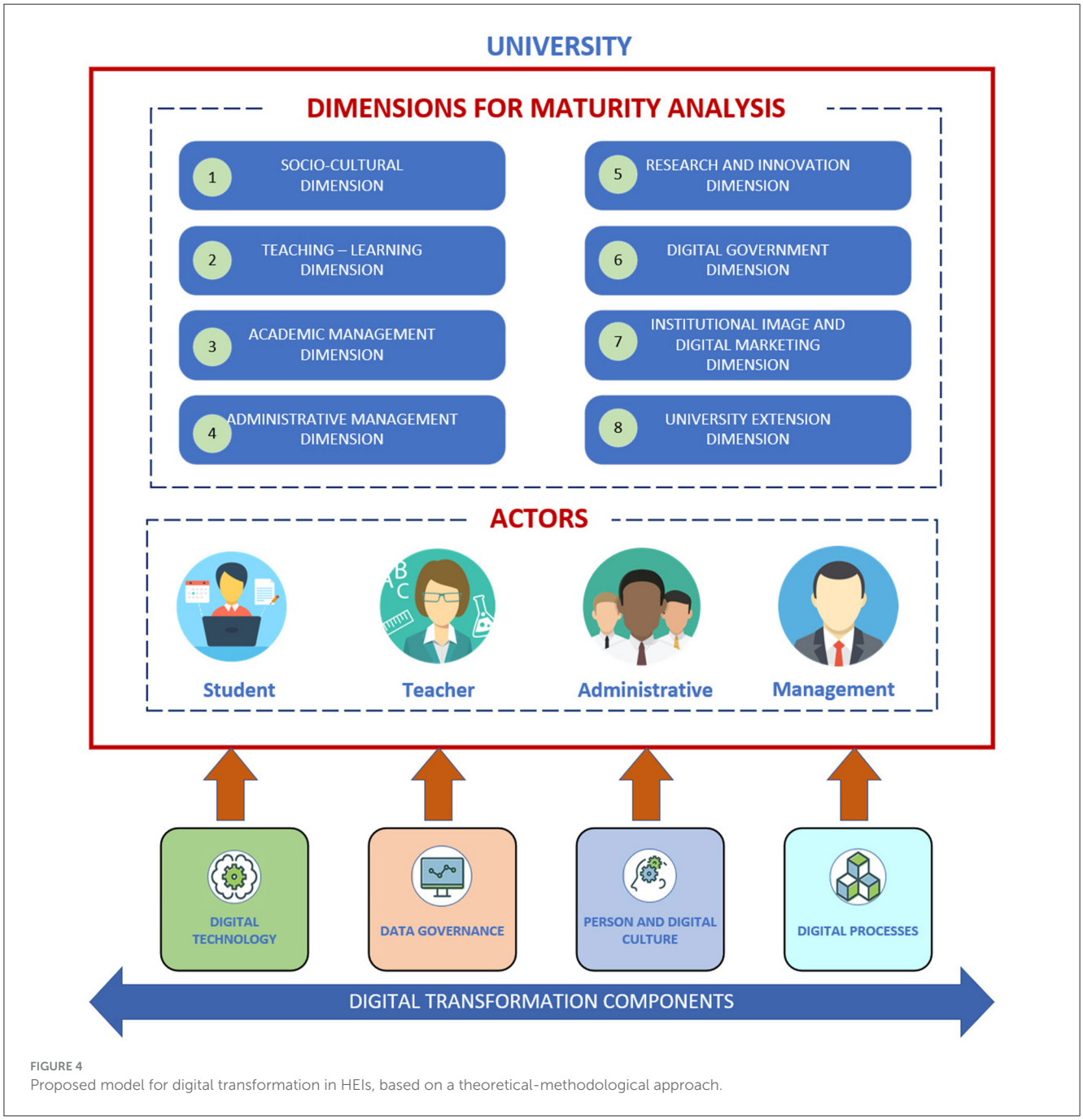

FIGURE 4
Proposed model for digital transformation in HEIs, based on a theoretical-methodological approach.

the administrative personnel who occupy a managerial or managerial position.

4.7 Phase 7: creation of the DT model

The MTM developed allowed proposing a model based on eight dimensions, where the academic and administrative processes that constitute the core of its activities are developed, as shown in Figure 4. The four identified key components of DT are integrated transversally: digital technology, data governance, people and digital culture, and digital processes.

The proposed model involves four actors immersed in the process of DT in HEIs: teachers, students, administrators, and managers.

4.8 Phase 8: determination of DT maturity levels

From the bibliographic review, based on research articles and measurement proposals of recognized companies, it became evident that they consider different levels of maturity for DT, most of them focused on companies from different sectors and very few directed to higher education.

This research takes into account three levels of maturity: beginning, in process, and continuous improvement, which are described in Table 2, according to the dimensions of the educational processes and the components immersed in DT.

5 Discussion

The model for assessing the level of DT maturity in HEIs proposed in this study responds to a growing need in academia, especially after the acceleration of digitization processes driven by the pandemic (Benavides et al., 2020). This MTM not only provides a comprehensive analytical structure but also lays solid foundations for the diagnosis and strategic planning of digitization in universities. In accordance with the objective of the research, which is to propose an MTM for the creation of a model to evaluate the levels of DT maturity in HEIs, a comprehensive model was built based on eight dimensions and four key components, validated through a case study and qualitative analysis in a faculty of a Peruvian university.

One of the main contributions of this study is the identification and structuring of eight essential dimensions in the DT of HEIs: socio-cultural, teaching–learning, academic management, administrative management, research and innovation, digital governance, institutional image and digital marketing, and university extension. These dimensions coincide with the proposals of Acuna et al. (2024), who stress the need for a holistic model that encompasses both technological infrastructure and administrative and educational processes.

Similarly, the inclusion of the four fundamental components of DT—digital technology, data governance, digital person and culture, and digital processes—aligns with the findings of Rodriguez-Abitia and Bribiesca-Correa (2021), who emphasize the importance of data governance and cultural change management in the implementation of digital strategies in education. The incorporation of these elements also coincides with the framework proposed by Aguiar et al. (2019), which highlights digital maturity as a continuous process of organizational adaptation driven by innovation capacity and institutional resilience.

Despite conceptual and methodological advances, the adoption of DT models in HEIs faces several barriers. Aditya et al. (2021a,b) identify resistance to change, lack of strategic alignment, and lack of digital skills as recurrent obstacles in these processes. In this sense, this study contributes to a structured guide that allows universities to identify their strengths and weaknesses in each dimension, facilitating evidence-based decision-making.

On the other hand, the digital maturity of HEIs depends not only on internal factors but also on the regulatory context and government policies. Initiatives such as the Política Nacional de Transformación Digital (2023) in Peru reflect an effort to establish regulatory frameworks that promote digitalization in the education sector. However, the effectiveness of these policies requires evaluation mechanisms to measure their impact on the digital evolution of universities (Draheim et al., 2021). An interesting approach is proposed by Castro et al. (2022), who highlight the need to develop valid and reliable measurement instruments to accurately assess digital maturity in diverse educational contexts.

This study highlights that DT in the context of HEIs remains an emerging field with multiple opportunities for exploration. The integration of AI in teaching and the automation of administrative processes are trends that could redefine the way universities operate and deliver their educational services (Zhao et al., 2024). In addition, continuous evaluation of the digital maturity model in different geographical and organizational contexts will refine its applicability and improve its effectiveness.

An important aspect that deserves more attention in future research is the impact of DT on the student experience. Espinosa-Vélez et al. (2022) emphasize that DT should not only focus on technological infrastructure and institutional management but also on improving student interaction with academic and administrative services. Similarly, studies such as that of Díaz-Garcia et al. (2023) suggest that digital maturity should be measured in terms of the degree to which universities can use digital tools to optimize the learning experience and promote access to quality education.

The qualitative analysis of the data collected from the interviews conducted with institutional actors, such as directors, deans, and administrative managers, made it possible to identify shared perceptions and specific challenges related to DT in an HEI. The need to strengthen the digital competencies of staff and align institutional practices with the strategic objectives of DT became evident. Although specific advances were reported, such as online enrollment and the use of academic platforms, technical limitations, dependence on manual processes, and partial implementation of emerging technologies persist. Similarly, institutional communication still relies on informal channels and systems without traceability, while data management lacks integration and standardization. These findings underscore the need to adopt a systemic and comprehensive approach, such as the one proposed in the maturity model developed in this study, to achieve an effective and sustainable DT.

TABLE 2 Proposed maturity levels.

Maturity level	Description according to dimensions	Description according to DT components
At beginnings	The IES is **in the initial phase** of DT. The digital tools and competencies used in the **teaching–learning process** are minimal, as well as the teaching methods applied. There is poor curricular planning and programming, as well as a lack of updating of study plans that do not involve students and graduates. Activities are not planned, organized, directed, and controlled in pursuit of institutional objectives. There are no activities that generate social and environmental impact. Scientific production is low, indexed databases are not used in scientific and educational research, and tools that support research and innovation are not used. There are shortcomings in the control and monitoring of the use of information technologies, problems in the quality of academic and administrative information systems, and a lack of consideration for data privacy and security. Communication channels do not involve all stakeholders, nor do they reach all levels, and there is no analysis of the competition. Knowledge transfer with the community does not take place.	This means that there is minimal automation of their academic and administrative **processes,** and disruptive or innovative **technologies** are not applied. **People (teachers, students, administrators, and managers)** are not involved and committed to the DT in the organization. **Data** analysis for decision-making and process improvement is not taken into account.
At process	The IES **is in the process of** moving toward DT. The digital tools and competencies used in the **teaching–learning process** are implemented, but not to their full potential, just as the teaching methods used are not applied effectively. Curricular planning and programming are being carried out, but it is still necessary to include many more variables and all stakeholders, and curricula should be updated on an ongoing basis. It plans, organizes, directs, and controls activities in pursuit of institutional objectives but does not apply tools and data analytics for better decision-making. Activities that generate a social and environmental impact are carried out, but not with the necessary level and frequency. Scientific production is regular, indexed databases are used in scientific and formative research but still low, and tools that support research and innovation are used, but not to their full potential. The control and monitoring of the use of information technologies is insufficient, which still leads to problems in the quality of academic and administrative information systems. Communication channels partially involve all stakeholders, and competition analysis is regular. Knowledge transfer with the community is insufficient.	There are initiatives to digitize academic and administrative **processes** and apply disruptive or innovative **technologies** through digital channels. People (teachers, students, administrators, and managers) begin to identify with the digital culture and become aware of the relevance of data analysis for decision-making and process improvement.
Continuous improvement	The IES is in **continuous improvement** toward DT. The digital tools and competencies used in the **teaching–learning process** are effective and achieve the purposes of the educational model. Curricular planning and programming are carried out, and curricula are updated on an ongoing basis, taking into account all the variables and actors involved. It plans, organizes, directs, and controls activities in pursuit of institutional objectives, efficiently applying digital tools and data analytics for better decision-making. Activities that generate a social and environmental impact are carried out on an ongoing basis. The scientific production is high, being a reference at national and international levels for the quality of the researchers and the research works generated that have an impact on society. The quality of the academic and administrative information systems is high, and they are monitored and updated according to user requirements. The communication channels used are effective, and the company has a national and global presence and visibility. Knowledge transfers with the community are of high impact.	Digitalization is used in all academic and administrative **processes,** and disruptive or innovative **technologies** are applied through digital channels that improve the service in fully virtualized environments. **People (teachers, students, administrators, and managers)** and the digital culture are the main axes of digital transformation; advanced **data** analysis is used for efficient decision-making that allows the formation of professionals that the globalized market needs and that adapts to the existing changes.

Similarly, this model represents a relevant contribution for HEIs globally, particularly in developing countries, where the digitalization of higher education is advancing unevenly. Its flexible nature and modular structure allow its adaptation to different geographical, regulatory, and cultural contexts, making it a useful tool for universities seeking to move toward a more digitized education, without losing sight of their academic mission and social commitment.

In summary, this study contributes to a comprehensive model that not only contributes to the theoretical development of the field but also provides a practical guide for HEIs to move strategically toward a sustainable, inclusive, and people-centered DT. Its adoption can become a key factor in consolidating a resilient, innovative higher education that is capable of responding to the challenges of the 21st century.

6 Conclusion

This study has developed an MTM for the creation of a model for assessing the level of DT maturity in HEIs. Through an exhaustive literature review and the analysis of key factors and dimensions, a comprehensive and applicable model has been developed that allows universities to assess their digital maturity in a systematic and accurate way.

The proposed model contributes to closing an important gap in the literature by providing a structured and contextualized approach to assessing digital maturity at the university level from a theoretical perspective. From the practical approach, HEIs can use this tool as a guide to enable them to formulate and implement more coherent DT strategies, aligned with their institutional needs and with the demands of the contemporary digital environment.

A methodology with a qualitative approach composed of eight phases was used to integrate the key elements to achieve DT in HEIs in an MTM. The literature review and the application of interviews with the institution's managers and administrative staff, with findings that provided real support to the theoretical framework defined.

Thus, eight dimensions were structured in the MTM for HEIs: socio-cultural, teaching–learning, academic management, administrative management, research and innovation, digital governance, institutional image and digital marketing, and university extension. The actors were students, teachers, administrative staff, and managerial staff. The four DT components were organized as follows: digital technology, data governance, person and digital culture, and digital processes.

As a recommendation, it is suggested that HEIs consider implementing the proposed model, integrating it into the processes of the DT plan, to continuously monitor the levels of digital maturity in the different areas of the university. On the other hand, it is recommended to develop a system of specific indicators for each dimension of the model, which allows for measuring the respective progress in an objective manner and supports data-based decision-making, as part of the quality management system of university education.

In addition, it is essential to strengthen the institutional digital culture, applying continuous training programs for teachers, administrators, and managers, focused on digital competencies, technological leadership, and change management.

As a final recommendation, it is suggested to prioritize investment in technological infrastructure that enables both digital operation and pedagogical innovation, collaborative research, and interoperability of systems.

The application of DT approaches in the context of HEIs is still an emerging field that has gained momentum after the pandemic, and this study constitutes an innovative initiative in this field by contributing to the theoretical knowledge on the basis of instruments to measure DT maturity levels.

However, this study is not without limitations. The validation of the model was performed through pilot applications in one HEI, which may not fully represent the diversity and complexity of all universities. In addition, rapid technological advancement means that the model must be periodically reviewed and updated to remain relevant.

For future research, it is recommended that the validation of the model be extended to a larger number of institutions and diverse geographical contexts.

Finally, the MTM and assessment model proposed in this study provide a valuable tool for HEIs in their journey toward DT, facilitating a more informed and strategic approach to achieve higher levels of digital maturity.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Comité de ética de la Universidad Nacional Pedro Ruiz Gallo. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

JB-J: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. RA: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. CV: Conceptualization, Data curation, Investigation, Methodology, Writing – original draft, Writing – review & editing. NG: Conceptualization, Data curation, Investigation, Methodology, Writing – original draft, Writing – review & editing. JA: Conceptualization, Methodology, Writing – review & editing. OS: Conceptualization, Methodology, Writing – review & editing. LG: Methodology, Supervision, Writing – review & editing. AH: Methodology, Supervision, Writing – review & editing.

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