

Towards a Collaborative Framework for the Implementation of Digital Transformation Processes in Higher Education Institutions: A Comparative Analysis

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Abstract. Digital transformation (DT) has become a strategic focus for higher education institutions (HEIs), driving the modernization of their core functions through the integration of technologies, data, and collaboration. This study proposes a collaborative framework based on a theoretical analysis of the main digital transformation models applied in universities, considering dimensions of digital maturity, data governance, technology adoption, and inter-institutional collaboration. Through a review of recent literature, the conceptual foundations and theoretical approaches that underpin the framework are identified, highlighting the need to articulate the strategic, technological, and organizational aspects within a collaborative environment. The resulting conceptual framework integrates principles of digital maturity, collaboration engineering, and institutional governance, offering an adaptable structure for Latin American contexts characterized by resource limitations and cultural challenges. Although the review was based on the Scopus database, which is a limitation in terms of comprehensiveness compared to other relevant sources such as IEEE Xplore, ACM Digital Library, or Web of Science, the results obtained provide a solid foundation for advancing the formulation of the conceptual framework. This work contributes to the development of knowledge by synthesizing the most relevant elements of existing models and offering a conceptual approach geared toward the sustainable implementation of digital transformation in higher education institutions.

Keywords : Digital transformation, digital maturity models, collaborative framework, data governance, technology adoption, Latin America.

1 Introduction

1.1 Context

Digital transformation (DT) has become a strategic priority for Higher Education Institutions (HEIs) in the second decade of the 21st century [1]. This evolutionary process uses digital capabilities and technologies to modernize business models, operational processes, and user experiences that generate value [2], emerging as a key element for strengthening teaching, research, community outreach, and university management. The adoption of emerging technologies such as online learning, artificial intelligence, and data analytics has allowed universities to adapt to the demands of the knowledge society.

However, digital transformation processes in higher education institutions are often fragmented and unsustainable, with isolated initiatives that fail to integrate strategic, technological, and organizational aspects [1], [3], [4]. This situation highlights the need to adopt an approach that goes beyond simple technological implementation to consolidate a collaborative digital transformation. This concept is understood as the coordinated integration of multiple stakeholders—faculty, students, administrative staff, directors, and external partners—in the design, implementation, and evaluation of institutional digitization processes. Collaboration, in this sense, becomes a cross-cutting axis that allows for resource sharing, the building of collective capacities, and the generation of value through co - creation and organizational learning.

Therefore, conducting a systematic literature review allowed us to identify several models that have been proposed to guide this digital transformation process in universities. Among these, digital maturity models stand out. [5]data governance [6]technological adoption [7]and inter-institutional collaboration [8]These models directly influence the design of the framework proposed in this study: for example, the technology adoption approach feeds the technological dimension of the framework, while the data governance model guides the digital information management component.

However, a consolidated collaborative framework to facilitate the effective implementation of digital transformation in higher education institutions (HEIs) with varying levels of technological maturity is still lacking. This situation highlighted the need for a systematic literature review and a comparative analysis of existing models to determine their applicability in specific contexts, such as that of Unicomfauca, a higher education institution located in Popayán, Cauca, Colombia.

1.2 Importance of the Study

Despite the growing academic and governmental interest in the digital transformation of universities, gaps persist in the literature, among which the following stand out:

- Lack of standardization in digital transformation models for higher education institutions[5]
- Scarcity of empirical assessments on digital maturity in Latin American universities[9], [10]
- Limited evidence on internal and inter-institutional collaboration in the implementation of digital transformation processes[5]
- Limited adaptability of existing models to contexts with specific technological and organizational constraints[11], [12]

This systematic review seeks to close these gaps through a comparative analysis of digital transformation models in higher education institutions, establishing the basis for the design of a collaborative framework adapted to the realities of Unicomfauca and other institutions in Latin America.

1.3 Research Problem

Although digital transformation is recognized as a critical factor for the modernization of universities, a collaborative framework that allows for its structured and sustainable implementation has not yet been developed. The research problem is formulated as follows:

How to implement a collaborative digital transformation framework to improve mission-critical processes in a higher education institution?

This problem arises from the lack of standardized criteria for measuring digital maturity, the limited internal and external collaboration between higher education institutions, and the need to adapt global models to the particular realities of Latin America.

1.4 Study Objective and Scope of the Review

The objective of this study is to conduct a systematic literature review, to make a comparative analysis of existing digital transformation models in the field of higher education in Latin America, as a basis for the construction of the theoretical foundations that support the design of a collaborative framework for the implementation of digital transformation processes in higher education institutions (HEIs).

To achieve this purpose, a systematic literature review is used as a rigorous method for analyzing and synthesizing existing knowledge, allowing for the identification of the conceptual approaches, dimensions, and components present in digital transformation models developed within the university setting. In this way, the study seeks to advance the formulation of a theoretical and conceptual framework that explains how the elements of digital maturity, data governance, technology adoption, and inter-institutional collaboration can be integrated into a coherent and contextualized model for higher education institutions, especially in Latin America.

1.5 Research Questions

The research questions guiding this article stem from the ongoing doctoral project entitled “Collaborative Framework for the Implementation of Digital Transformation Processes in Higher Education Institutions.” However, this work focuses solely on the theoretical and analytical phase, corresponding to the state of the art and the construction of the conceptual framework that underpins the subsequent development of the model. Therefore, the questions directly addressed in this article are described in Table 1. These four questions guide the analysis and discussion of the article, whose main purpose is to synthesize the theoretical foundations necessary to structure a collaborative framework for digital transformation.

Table 1. Research Questions

No.	Ask
P1	What are the models or theoretical frameworks for digital transformation developed for higher education institutions?
P2	What conceptual dimensions and levels of collaboration are identified in these models?
P3	What are the most commonly used digital maturity and data governance criteria in the university context?
P4	What theoretical gaps and conceptual limitations does recent literature on digital transformation in Latin American universities present?

This document provides an overview of published research in this field through a systematic literature review (SLR) of digital transformation models or frameworks in higher education institutions (HEIs). The document is structured as follows: The Introduction section presents the current SLR related to digital transformation models or frameworks for HEIs, defining the importance of the study, the research problem, the objectives, and the research questions. In the Methodology section, the authors describe the protocol followed, the process of extracting relevant data, and the results obtained. The Discussion section offers a debate to answer the research questions. Finally, the Conclusions and Recommendations section presents the inferences drawn.

2 Methodology of the Systematic Review

The methodology adopted in this study combines a systematic literature review (SLR) with a theoretical and conceptual construction process, aimed at defining the foundations of the Collaborative Framework for Digital Transformation (CFDT) in higher education institutions (HEIs).

This methodological structure responds to the general objective of the article: to advance in the development of the conceptual framework that supports the MCTD proposal, using systematic review as a means to analyze and synthesize the available scientific evidence.

2.1. Phase 1. Systematic review of the literature

The purpose of this first phase was to identify, classify, and analyze the models and conceptual frameworks of digital transformation applied in universities, in order to recognize their approaches, dimensions, and theoretical gaps. The procedure followed the PRISMA protocol (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), [13] widely used to ensure transparency and rigor in scientific reviews. The process was developed in four stages:

- Identification: search scientific databases.
- Screening: elimination of duplicates and preliminary analysis of titles and abstracts.
- Eligibility: complete review of the selected texts, evaluating their quality and relevance.
- Inclusion: final selection of studies that met the inclusion criteria, for detailed analysis.

2.1.1. Data sources

The bibliographic search was carried out in the Scopus database, selected for its relevance and coverage of high-quality scientific publications, especially on topics of digital transformation in higher education ([14]).

2.1.2. Search strategy

The search strategy was meticulously designed to ensure comprehensiveness and relevance, adapting to the research questions and the PICO framework guidelines. Table 2 describes the terms used in this research to construct the search string. The search was conducted in the Scopus database, considering studies published between 2019 and 2024.

Table 1 Search Terms	
Main Term	Related terms
Digital Transformation	Digital Transformation, Digital Transformation Models, Digital Transformation Framework, Digitization
Higher Education Institutions	Universities, Education
Search string used	
(("Digital Transformation") OR ("Digitalization") OR (" Digitalization ") OR ("Digital Transformation Model") OR ("Digital Transformation Models ") OR ("Digital Transformation Framework") OR ("Digital Transformation Framework") AND ("Higher Education Institutions") OR ("Universities") OR ("Universities") OR ("Education") OR ("Education"))	

Selection of studies

The studies were selected according to the criteria described below.

Inclusion and Exclusion Criteria.

The authors [15] clarified that research identified through electronic and manual searches could be unequivocally excluded based on the title and abstract, requiring a full copy. Furthermore, redundant references were systematically removed using Mendeley software. The inclusion and exclusion criteria, in accordance with the methodology, allowed for the filtering of studies that were not relevant to the defined research questions. In this case, the following articles were considered inclusion criteria:

- 1) Publications in indexed scientific journals and peer-reviewed conferences.
- 2) Studies published between 2019 and 2024 .
- 3) Studies that propose models or frameworks for digital transformation applicable to higher education institutions or universities.
- 4) Articles in English and Spanish . 5) Studies that include digital maturity measurement and inter-institutional collaboration .

The following items are considered exclusion criteria:

- 1) Studies that do not propose a structured model of digital transformation.
- 2) Publications without peer review (blogs, opinion articles).
- 3) Documents focusing on other sectors (businesses, health, etc.).
- 4) Duplicate studies or studies without access to the full text.

Item Selection Process.

The selection process was carried out in four phases, following the PRISMA model:

- 1) Identification: 95 studies were found after applying the search strategy in the Scopus database.
- 2) Screening: 0 duplicate studies were eliminated .
- 3) Eligibility: Titles and abstracts were reviewed, excluding 24 studies that did not meet the criteria.
- 4) Inclusion: Finally, 15 articles were selected for detailed analysis.

Figure 1 describes a summary of the PRISMA protocol.

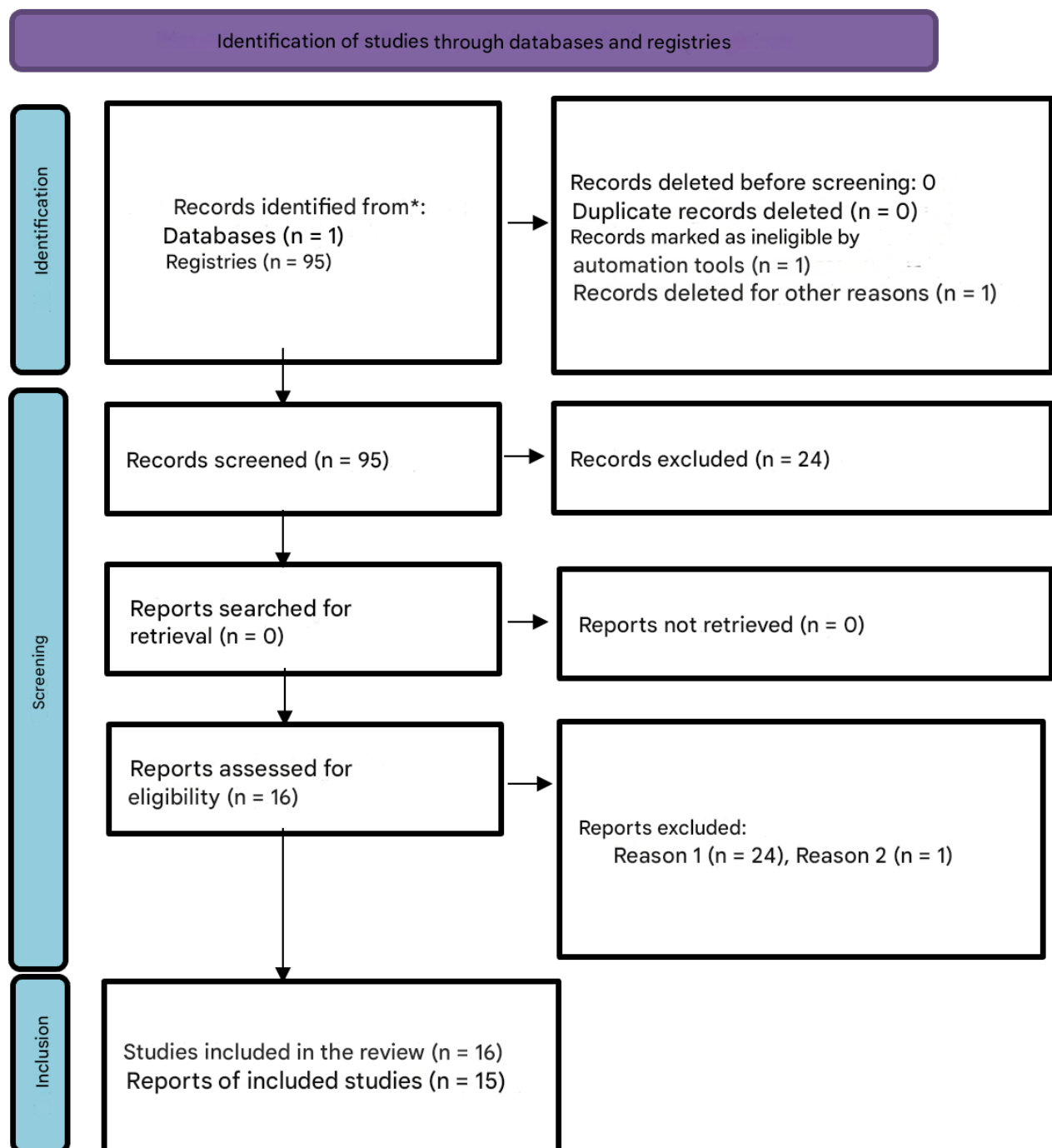


Figure 1: PRISMA Protocol Application

During the screening and eligibility phase, two independent reviewers conducted the selection process for the studies identified in the Scopus database. Both applied the same inclusion and exclusion criteria established in the PRISMA protocol. Disagreements regarding the relevance of an article were discussed and resolved by consensus, ensuring the consistency and objectivity of the process. In the pre-selection phase, 24 studies were excluded, primarily for not meeting the defined criteria. Table 3 summarizes the main reasons for exclusion.

Table 3. Reasons for exclusion identified

Reason for exclusion	Description	No. of excluded studies
They did not address the context of higher education institutions	The study's focus was on businesses, healthcare, or other sectors.	9
They did not present a structured model or framework for digital transformation.	Articles focused on perceptions, policies or experiences without a methodological proposal or conceptual model.	7
They lacked peer review or were technical reports without academic validation	Non-peer-reviewed publications, institutional reports, or policy documents.	4
Duplicates or without access to the full text	Repeated records or lack of full content availability.	2
They did not meet the established time frame (2019–2024)	Studies prior to the reference period.	2
Total number of excluded studies		24

2.1.4. Evaluation of the quality of studies

To measure the quality of the selected studies and determine their relevance, a structured questionnaire was developed with five key questions and a three-point scoring system (-1, 0, and +1). Table 4 shows the questions to consider when evaluating the studies and the scores assigned according to the possible answers.

Table 4. Quality assessment criteria

Questions	Evaluation scale
The study proposes a framework, roadmap, or set of elements described in detail to carry out digital transformation processes in higher education institutions or universities.	Measurement scale:
The study presents results from the implementation of a model or framework of digital transformation in higher education institutions or universities	Si = 1.0
The study presents collaborative work initiatives to support transformation processes digital universities.	Partially = 0.5
	No = 0.0
The research presents the construction of a digital transformation model and/or work collaborative in organizations	Measurement strategy:
Describe the benefits and challenges involved in adopting digital transformation processes in organizations?	Maximum rating: 7.0
	Minimum rating: 2.0
	Minimum acceptance score: 2.5

2.1.5. Data Extraction and Analysis

Design of data extraction forms. The computer software used for data management and analysis of the information contained in the articles included Mendeley and Microsoft Excel. Mendeley was used to monitor the articles obtained by querying the database, effectively eliminating redundant references and classifying the information within each article, making distinctions by applying different colors according to the designated category. Conversely, Microsoft Excel was used to document and organize the data generated from the subsequent protocol. The workbook was structured with several tabs, meticulously recording each distinct phase. Complete information can be accessed in the supplementary materials.

Data Extraction Procedures. The methodology used for data collection was systematically structured in three distinct phases. Information Analysis: The dissection and categorization of the data were carried out using an inductive analytical approach. Textual segments that provided answers to the research questions were distinctively marked using varied color coding, facilitated by Mendeley software. This methodological approach allowed for a deeper engagement with the text and facilitated a meticulous process of examination and categorization. In Phase 2, Information Classification: the coding of labels with the intention of attributing representative meaning to the highlighted data was established concurrently with the information analysis phase.

Finally, Phase 3, Information Extraction: each segment of the text emphasized during the information analysis phase was systematically classified according to the codes outlined during the classification phase. A spreadsheet application was used to effectively manage the resulting information. This application can be accessed via the following link: <https://surl.li/tpdrqn>

2.1.6. Information Summary

As a synthesis method, information from selected studies was extracted and structured by adapting the bibliographic cards proposed by [16]: Identification (title, authors, year of publication, keywords), type of study, objective of the study, type of model/framework, dimensions of the model, components of the model, method/approach, scope of application, level of collaboration, maturity measurement, main findings, gaps/voids in the literature, main conclusions, relevance for the development of the collaborative framework, applicability in Colombia (Unicomfacaucá).

2.2. Phase 2. Construction of the collaborative theoretical framework

Based on the findings of the systematic review, a second methodological phase was developed aimed at synthesizing the theoretical and structural components that underpin the collaborative framework for digital transformation (MCTD).

This phase followed a conceptual analysis and theoretical design approach, based on three procedures:

1. Theoretical synthesis and categorization: common conceptual constructs were identified among the analyzed models (digital maturity, governance, culture, collaboration, analytics, academic processes).
2. Conceptual integration : the constructs were related under a systemic and collaborative logic, identifying their interdependencies.
3. Design of the preliminary conceptual framework : the structuring dimensions (strategic, technological, organizational, data governance and collaboration) were established, as well as the transversal theoretical principles that guide the framework.

The result of this phase was not an operational model, but rather the definition of the theoretical framework that guides its subsequent development and empirical validation in the doctoral project. As a methodological summary, it can be stated that the adopted methodology articulates two complementary levels:

- Systematic review as a procedure for searching, selecting and analyzing scientific evidence;
- And theoretical construction as a process of conceptual integration aimed at formulating a coherent and contextualized framework.

This methodological combination ensures that the proposed framework is not based solely on a bibliographic analysis, but on a structured and well-founded theoretical synthesis as a result of a comparative analysis of digital transformation models in the field of higher education, capable of guiding the subsequent design of the digital transformation framework (DTF) in real contexts.

3. Results

This segment is organized according to the research and mapping queries synthesized from the article evaluation, following the information analysis process outlined in the review protocol. Additionally, the data obtained from the review protocol are added to the spreadsheet. <https://surl.li/tpdrqn>

3.1. Studies included and excluded

After applying the selection process based on the PRISMA methodology, a total of 95 studies relevant to the analysis of digital transformation models in higher education institutions were identified. Of these, 80 articles were excluded for not meeting the inclusion criteria, resulting in a final sample of 15 studies that form the basis of the analysis.

3.2. General characterization of the studies analyzed

The selected studies cover diverse geographic regions, research methodologies, and areas of application. The following table summarizes their characteristics:

Table 5. Characteristics of the studies analyzed

Characteristics	Categories	Number of Studies
Geographic Region	Latin America	5
	North America	3
	Europe	4
	Asia	2
	Global	1
Research Method	Qualitative	6
	Quantitative	5
	Mixed	4
Scope of Application	Public universities	6
	Private universities	4
	Individual case studies	3
	General models applicable to multiple universities	2

This characterization reflects that the focus on digital maturity models responds to the priority of systematically evaluating the state of digitization in universities, especially in regions undergoing technological consolidation such as Latin America.

3.3. Main models/frameworks of digital transformation in universities

The models identified in the literature can be grouped into four main categories, as shown in Table 6:

Table 6. Main models of digital transformation in universities

Identified Models	Description	No. Studies	Studies
Digital Maturity Models	They evaluate the level of institutional digitization based on key dimensions such as infrastructure, digital skills, and technological adoption.	6	Rodríguez et al. (2021), Martínez et al. (2021), Giant et al. (2021), Timokhova et al. (2022), Langseth et al. (2023), Castro et al. (2023)
Data Governance Models	They focus on the management and administration of digital information within universities, ensuring security and efficiency in academic and administrative processes.	3	Abdulfattah et al. (2020), García et al. (2021), Taher et al. (2023)
Digital Collaboration Models	They promote the integration of multiple actors within the university ecosystem (administrators, teachers, students and external entities) to facilitate digital transformation.	4	Alenezi et al. (2021), Castillo et al. (2021), Quaiacoe et al. (2023), Ramírez-Montoya et al. (2022)
Technology Adoption Models	They analyze the implementation of emerging technologies and their impact on educational and administrative processes.	2	Aditya et al. (2023), Nurhas et al. (2022)

The preponderance of digital maturity models reflects the need for universities to systematically measure their digital progress in order to guide strategic decisions.

3.4. Patterns and Trends

Based on the analysis of the selected studies, the following trends are identified:

- Predominance of digital maturity models (40% of studies), demonstrating that measuring the level of transformation is an institutional priority.
- A higher frequency of qualitative approaches suggests that digital transformation is still studied more as an exploratory phenomenon than a quantifiable one.
- Limited presence of data governance models, possibly due to siloed academic structures, where each department manages its information in isolation.
- Emerging digital collaboration models are fundamental in universities with limited resources, although they are still poorly integrated into formal strategies.

3.5. Comparative Analysis of Digital Transformation Models

- Digital transformation models in higher education institutions present significant differences in terms of their approach, level of collaboration, and applicability.
- Digital Maturity Models have been the most widely used due to their ability to assess the degree of digitization in universities. However, their effectiveness depends largely on the adoption of standardized metrics and their alignment with institutional objectives. These models typically require a medium-to-high level of collaboration, as they involve multiple internal stakeholders, such as faculty, administrative staff, and students.
- Data governance models focus on the efficient management of digital information, but their applicability in higher education is limited compared to more regulated sectors, such as the corporate or governmental sectors. These models exhibit a moderate level of collaboration, as they involve technical areas within universities, but not necessarily the academic community as a whole.
- Digital Collaboration Models have proven effective in integrating key stakeholders within the university ecosystem. Unlike digital maturity models, these models emphasize cooperation among different institutions, including partnerships with the private sector and government agencies. Their main limitation is the lack of mechanisms for measuring digital maturity, which hinders systematic evaluation. However, they offer a high level of collaboration, facilitating their implementation in resource-constrained environments.
- Finally, Technology Adoption Models focus on incorporating new digital tools into teaching and academic administration. Although their application is broad, their approach is based on technological implementation without necessarily considering a structured framework for digital transformation. These models tend to have a low to medium level of collaboration, as they are often driven by administrative decisions without an active participation process from the entire university community. Table 7 consolidates the comparative analysis of Digital Transformation Models.

Table 7. Comparative Analysis of TD Models

Model/Frame	Level of Collaboration	Maturity Measurement	Methods Used	Applicability in Higher Education Institutions
Digital Maturity	Medium – High	Yes	Qualitative/Quantitative	High
Data Governance	Half	Yes	Qualitative	Moderate
Digital Collaboration	High	No	Mixed	High
Technology Adoption	Low – Medium	No	Quantitative	Moderate

During the analysis phase, the recurring components of the various digital transformation models in higher education were grouped under common conceptual categories. These dimensions do not originate from a single model, but rather emerge from the convergence of widely cited theoretical frameworks in the literature, including:

- digital maturity models (Rodríguez- Abitia and Bribiesca-Correa, 2021),
- which emphasize infrastructure, culture, and academic processes; data governance models (García-Peñalvo, 2021; Taher et al., 2023),
- which contribute the dimension of institutional governance
- and models of digital collaboration and university ecosystems (Alenezi, 2021; Ramírez-Montoya et al., 2022), which introduce the collaborative dimension and data analytics for decision-making.

The synthesis process allowed these elements to be organized into six cross-cutting analytical dimensions, which serve as comparative criteria between models and as a theoretical foundation for the development of the Collaborative Working Framework (CWFF). Figure 2 describes a cross-tabulation matrix of the model categories against the dimensions identified above.

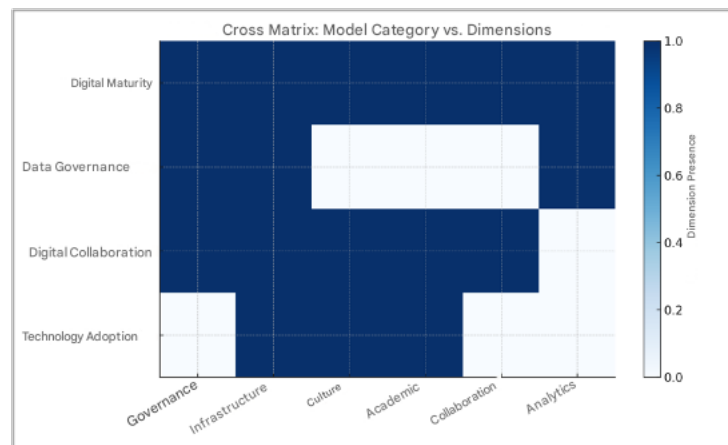


Figure 2: Cross Matrix of Model Category vs. Dimensions

Figure 2 shows which key dimensions are addressed by the different types of models. Digital maturity models stand out for integrating all six dimensions analyzed: governance, infrastructure, organizational culture, academic processes, collaboration, and analytics. In contrast, technology adoption models have limited coverage, mainly focused on infrastructure, culture, and digital pedagogy. Digital collaboration models, on the other hand, show a strong presence of relational and cultural components, but less integration of analytical tools.

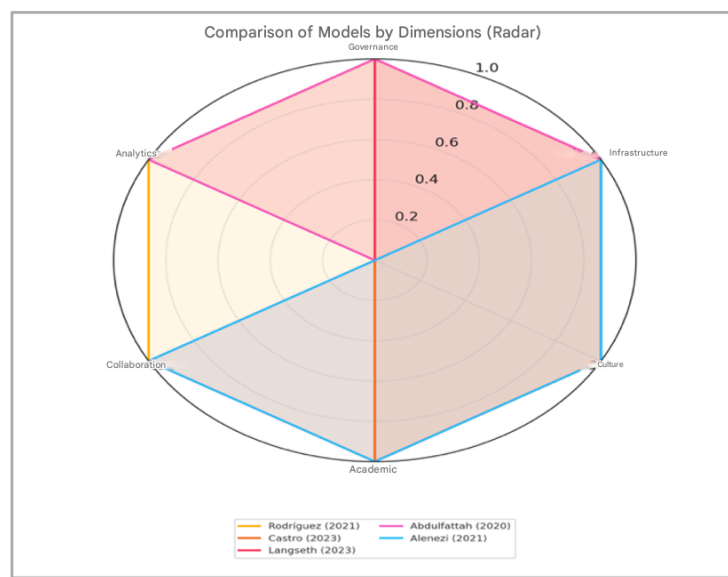


Figure 3: Comparison of Models by Dimensions (Radar)

Figure 3 allows for a comparison of the dimensional coverage of five representative models: Rodríguez (2021), Castro (2023), Langseth (2023), Abdulfattah (2020), and Alenezi (2021). It can be observed that the Rodríguez and Langseth models present complete or near-complete coverage of the six key dimensions. Castro also presents a robust structure, although it does not directly address collaboration mechanisms. At the other end of the spectrum, Abdulfattah focuses on governance and infrastructure, while Alenezi prioritizes culture and academic processes. This comparison allows for the identification of comprehensive models versus those with a more partial or specific focus.

To answer research question RQ2: What are the most common dimensions assessed in digital maturity models?, the dimensions identified in the 15 reviewed models were grouped and classified under standardized labels. They were organized by model category: Digital Maturity, Data Governance, Digital Collaboration, and Technology Adoption. The visualizations below allow for a comparative analysis of the dimensional coverage in each category.

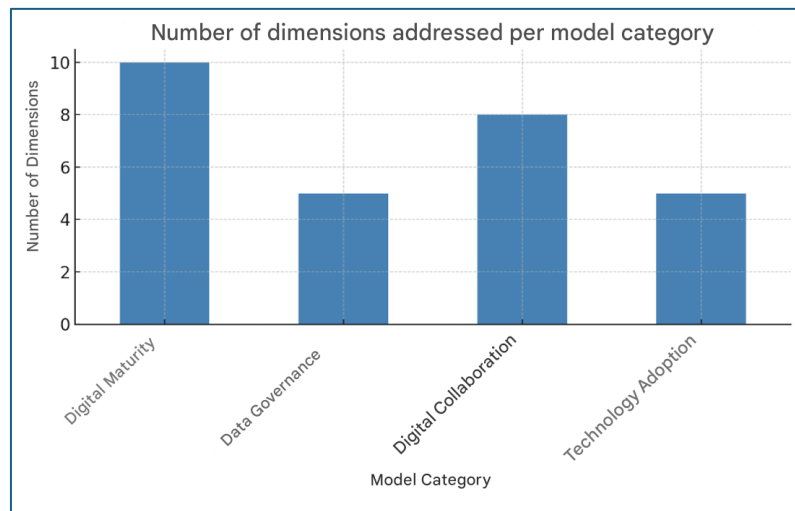


Figure 4: Number of dimensions addressed per model category

Figure 4 shows how many key dimensions each model type addresses. Digital maturity models stand out with comprehensive coverage, followed by digital collaboration models. Models focused on data governance and technology adoption exhibit less dimensional variety, suggesting a more specific or technical approach.

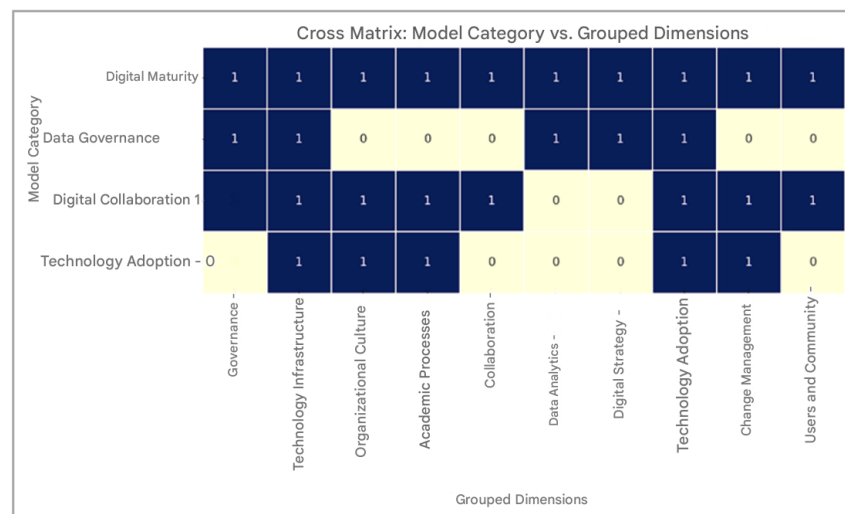


Figure 5: Cross-matrix Model Category vs. Grouped Dimensions

The heat matrix described in Figure 5 presents the level of presence of each dimension grouped within the identified model categories. It can be observed that the 'Technological Infrastructure' dimension is common to all categories, while 'Collaboration' and 'Data Analytics' are more concentrated in specific models. This visualization allows for the identification of patterns, strengths, and gaps by modeling approach type. This analysis supports the need to develop more comprehensive and collaborative frameworks that coherently and contextually incorporate multiple dimensions. The variety in current coverage demonstrates that, while there is progress, there are opportunities to strengthen approaches in areas such as analytics, organizational culture, and structured collaboration—essential aspects that the MCTD seeks to integrate systematically.

Taken together, these charts and their analysis lead to the conclusion that, while there is a shared set of fundamental dimensions for structuring digital transformation in universities, current models address them with varying depth and breadth depending on their approach. This heterogeneity presents an opportunity to propose more integrative frameworks, such as the MCTD model proposed in this research, which aims to articulate collaboration, maturity, governance, and applicability within a single contextualized framework. The following sections examine in greater depth the collaborative component (RQ3) and knowledge gaps (RQ4) in the reviewed literature.

3.6. Collaborative Practices Documented in the Models

To answer the third research question, the degree to which the collaborative component was incorporated into the analyzed models was examined. Models were considered collaborative if they explicitly proposed the participation of multiple actors, synergies between departments, or inter-institutional mechanisms for implementing digital transformation. The review revealed that models categorized as 'institutional collaboration' explicitly include this component, while others, such as digital maturity models, tend to focus more on structural processes without detailing the collaborative dynamics.

This section addresses research question RQ3: What level of collaboration do digital transformation models in higher education exhibit? To this end, the 15 models identified in the systematic review were analyzed based on their capacity to integrate institutional stakeholders into digital transformation processes. Collaboration was classified into three levels: Low, Medium, and High, according to the degree of participation of various stakeholders, including administrators, faculty, students, and administrative staff.

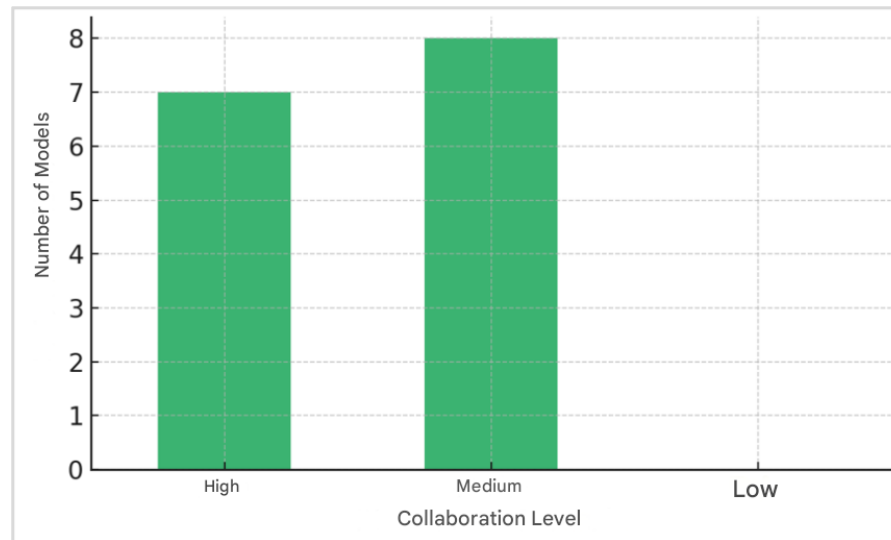


Figure 6: Distribution of the Level of Collaboration in the Models

The chart shows that most models fall into the 'High' collaboration category, indicating a growing trend toward the integration of multiple institutional actors in digital transformation processes. This aligns with recent literature that emphasizes the need for participatory and collaborative approaches to ensure the adoption and sustainability of digital initiatives. Below is a summary table showing the level of collaboration for each model and a brief description of how it involves actors in its implementation process.

Table 8. Level of Collaboration and Participation of Actors by Model

Model (Author, Year)	Level of Collaboration	Actor Participation
Abdulfattah & Almaghthwi (2020)	High	It involves actors including management, IT staff, employees, and stakeholders in the development and implementation of data governance policies.
García-Peñalvo (2021)	High	It involves actors such as faculty, students, and service staff in the digital transformation process, emphasizing collaboration among stakeholders.
Giang et al. (2021)	High	The study involves different actors, including students, administrative staff and teachers, in the process of evaluating readiness for digital transformation.
Langseth et al. (2023)	High	The study involves multiple actors, including support staff, faculty, and other colleagues, to describe how online course production and collaboration are supported within the processes.
Martínez & Rodríguez- Abitia (2021)	High	The study involves multiple actors, including governments, universities, and educational communities, to foster collaboration in digital transformation processes.

Taher (2023)	High	The study involves numerous actors, including students, parents, academics, education experts, and media professionals, through a research approach that analyzes the opinions and experiences of all these groups in the transformation process.
Timokhova et al. (2022)	High	It involves multiple stakeholders such as students, academic and administrative staff in the transformation process through interviews, surveys and focus groups, ensuring that their needs and opinions influence the development of the model
Rodriguez & Bribiesca-Correa (2021)	Half	The study involves various educational institutions in its evaluation process, as well as the collaboration of researchers from different countries to validate the instrument used
Aditya & Andrisyah (2023)	Half	not specified
Alenezi (2021)	Half	since the study mentions the importance of collaboration between different actors (administration, faculty, students) in the digital transformation process.
Castillo et al. (2021)	Half	It involves actors such as teachers, students, and administrators through surveys and analysis of their experiences in the digitization process.
Marks et al. (2020)	Half	It involves academics, IT directors, and administrators in the research process, especially through interviews and surveys.
Castro Benavides et al. (2023)	Half	The study involves various actors within the transformation process, including administrators, teachers, and students, promoting collaboration among stakeholders.
Nurhas et al. (2022)	Half	since it involves different actors (students, teachers, administrative staff) in the process of identifying and prioritizing challenges.
Quaicoe et al. (2023)	Half	It involves various educational actors, such as school leaders and teachers, in the formulation and implementation of digital innovation plans.

This analysis shows that models with a higher level of collaboration tend to have a more holistic approach, including both decision-makers and end users. However, some models still have limited or technical approaches that do not fully consider the participatory dimension. This reinforces the need for frameworks like the MCTD, which promote structured, inclusive, and collaborative environments aligned with the core processes of higher education institutions.

3.7. Gaps and challenges identified in the literature

This section addresses research question RQ4: What are the main gaps in the literature on digital transformation in Latin American universities? Based on the analysis of the models included in the systematic review, critical gaps were identified in the dimensional coverage and collaborative approach adopted by existing frameworks. These gaps justify the need for a new, contextualized framework.

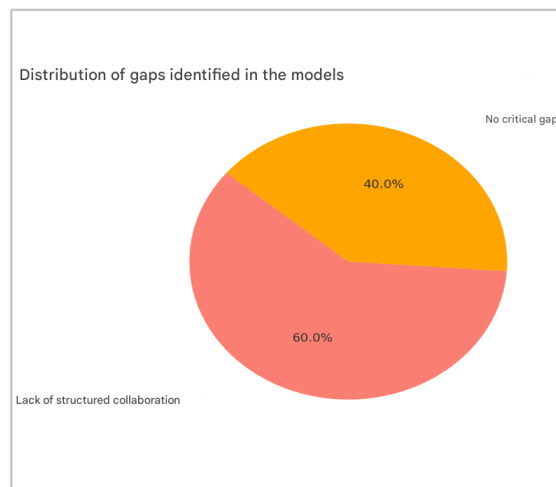


Figure 7: Distribution of identified gaps

Figure 7 shows that a significant portion of the models exhibit at least one of two critical gaps: limited coverage of key dimensions and/or a low level of institutional collaboration. Both deficiencies reduce the practical applicability of the models, especially in contexts like Latin America where the dynamics of digital transformation demand integrative and participatory approaches. Table 9 below summarizes the gaps identified by each model analyzed.

Table 9. Gaps by model

Model	Dimensions Addressed	Gaps Identified
Technology Adoption Model	6	Lack of structured collaboration
Digital Maturity Model	18	Lack of structured collaboration
Data Governance Model	8	Without critical gaps
Digital Collaboration Models	16	Lack of structured collaboration

The comparative analysis reinforces the need to propose a new framework that addresses these weaknesses. The Collaborative Framework for Digital Transformation (CFDT) is designed to integrate multiple strategic, organizational, technological, and human dimensions with an explicitly collaborative approach. It also seeks to address the lack of empirical validation, local context, and adaptability observed in many existing models.

Gaps. The systematic review has identified several gaps in the literature on digital transformation in higher education institutions. Among them, the lack of comprehensive models that combine elements of digital maturity and inter-institutional collaboration stands out. Many models focus on only one dimension, neglecting a holistic approach that considers both the technological infrastructure and the participation of different stakeholders within the institution.

Another significant gap in the literature is the scarcity of research on the impact of data governance in universities. While data management models exist for other sectors, adapting them to the educational field remains a challenge. The lack of standards for data management in academic institutions limits evidence-based decision-making and the efficiency of administrative processes.

Furthermore, there is a clear need to develop standardized metrics to evaluate digital transformation in universities. Currently, models use heterogeneous indicators, making it difficult to compare institutions and measure progress over time.

- Lack of comprehensive models that combine digital maturity and inter-institutional collaboration.
- Limited research on the impact of data governance in universities.
- Need to develop standardized metrics for the evaluation of digital transformation in higher education institutions.

Challenges . The challenges of implementing digital transformation in higher education range from technological aspects to organizational barriers. A key challenge is the effective implementation of models in universities with limited resources. Many institutions face difficulties adopting digital models due to budget constraints, which hinder investments in infrastructure and training.

Another challenge is training teachers and administrators in digital skills . The adoption of new technologies requires that educational stakeholders develop skills that allow them to use them effectively. Without ongoing training strategies, the impact of digital transformation may be limited.

Finally, integrating collaborative models with sustainable institutional policies presents a significant challenge. A lack of alignment between digital strategies and institutional planning can lead to isolated efforts that fail to consolidate over time. It is necessary to establish regulatory and governance frameworks that enable the continuity and expansion of digital initiatives in higher education.

- Effective implementation of models in universities with limited resources.
- Training of teachers and administrative staff in digital skills.
- Integration of collaborative models with sustainable institutional policies.

4. Discussion

4.1. Critical analysis of the identified models.

Digital transformation models in higher education institutions present diverse approaches, ranging from digital maturity assessments to data governance and inter-institutional collaboration. The comparative analysis identified significant differences in the approach, applicability, and effectiveness of each model.

Digital Maturity Models stand out for their ability to provide a clear measurement of the state of digitalization in universities. However, their limitation lies in the need for standardized metrics and their dependence on internal structural factors. In contrast, Data Governance Models have proven fundamental for the efficient management of digital resources, although their approach is more technical and less pedagogical.

Digital Collaboration Models have emerged as a key strategy for boosting digital transformation, enabling cooperation among different actors within the university ecosystem. However, their success depends largely on the existence of strategic alliances and clear institutional policies. Finally, Technology Adoption Models have been widely implemented, but in many cases lack an organizational structure that guarantees their long-term sustainability.

4.2. Evaluation of the applicability of the models in Latin American universities.

Applying the reviewed models in Latin American universities faces multiple challenges. Institutions in the region often have limitations in technological infrastructure, investment in digitization, and faculty training in digital skills. While Digital Maturity Models can be useful for establishing initial diagnoses, their effective implementation requires significant resources.

Data governance models, on the other hand, have not yet been widely applied in Latin American universities, which represents an opportunity for future research and practical applications. In contrast, digital collaboration models have shown greater viability in the region, especially through inter-university consortia and international cooperation programs.

4.3. Reflection on the adaptation of these models at Unicomfacauc

In the context of Unicomfacauc, the adoption of a digital transformation model must consider the institution's reality, including its technological and organizational capacity. A hybrid approach that combines elements of digital maturity, digital collaboration, and data governance could be an effective strategy to ensure sustainable implementation.

The university could benefit from adopting digital maturity metrics to assess its progress, while simultaneously strengthening inter-institutional collaboration with other universities and government agencies. Data management must play a crucial role in this process, ensuring that information is used strategically for academic and administrative decision-making.

4.4. Implications for future research.

Proposal for a collaborative framework for digital transformation in higher education institutions based on analyzed models. To structure the collaborative framework, the authors propose identifying key dimensions and fundamental components based on the analyzed models. These dimensions will enable a structured and sustainable implementation of digital transformation in higher education institutions.

Dimensions of the Collaborative Framework:

1. Strategic Dimension:

- Development of institutional plans for digital transformation.
- Definition of key performance indicators (KPIs).
- Creation of policies for the adoption of technology and digitization of processes.

2. Technological Dimension:

- Implementation of robust digital infrastructure (cloud) computing , Big Data, AI).
- Use of online learning platforms and digital tools.
- Evaluation of the interoperability of technological systems.

3. Organizational Dimension:

- Promoting digital culture within the university.

- Training and continuing education in digital skills.
- Creation of multidisciplinary teams to lead the digital transformation.

4. Data Governance Dimension:

- Establishment of regulations for data management.
- Implementation of information security and privacy strategies.
- Use of data analytics for institutional decision-making.

5. Collaboration and Networking Dimension:

- Promoting internal collaboration within the university between different departments, faculties and research centers.
- Creation of participation mechanisms for key actors within the institution (administrators, teachers, students and managers).
- Creation of strategic alliances with other universities, governments and the private sector.
- Promotion of knowledge and experience exchange networks in digitization.
- Development of joint financing initiatives for digital transformation.

Fundamental Components of the Framework:

- Digital Maturity Diagnosis and Measurement: Tools and methodologies to evaluate the current level of digitization of the institution.
- Implementation and Monitoring Strategies: Operational planning with clear phases and evaluation mechanisms.
- Training and Awareness: Training programs for teachers, administrative staff and students.
- Monitoring and Continuous Improvement Systems: Periodic evaluations to adjust strategies and ensure the sustainability of the process.
- Digital Governance Regulations and Policies: Guidelines that regulate the use, protection and exploitation of technology in higher education.

This collaborative framework enables the effective integration of technology, data governance, and institutional cooperation, ensuring that digital transformation in universities is a continuous, structured process adaptable to different contexts.

Based on the analysis conducted, a collaborative framework is proposed that integrates the most effective elements of the reviewed models. This framework is based on the following principles:

- Digital Maturity Assessment : Implement a diagnostic system to measure the level of institutional digitization.
- Data Governance : Developing strategies for the management and protection of digital information.
- Interinstitutional Collaboration : Fostering strategic alliances with other universities, companies and public bodies.
- Continuing Education : To train teachers and administrators in the use of digital technologies to ensure effective adoption.
- Financing Strategies : Identify sources of financing for the sustainability of digital transformation processes.

4.5. Opportunities for improvement in the transition to the design of the Digital Transformation Framework - MCTD

This section summarizes the main findings of the systematic literature review and comparative analysis of existing models, justifying the need for and relevance of the proposed framework. The analysis developed in this section identified and classified fifteen models and frameworks related to digital transformation in higher education institutions. Based on the systematic review and its subsequent comparative analysis, the four research questions were answered, yielding key findings that guide the design of the Collaborative Framework for Digital Transformation (CFDT).

First, it became evident that while a variety of approaches exist, including models of digital maturity, data governance, institutional collaboration, and technology adoption, these differ widely in terms of formalization, applicability, and coverage of key dimensions. The technological infrastructure dimension was extensively considered, but others, such as organizational culture, data analytics, and structured collaboration, were addressed only partially or marginally. Secondly, it was found that only a portion of the models explicitly incorporate collaborative processes with multiple institutional

actors. Analysis of the level of collaboration revealed that a significant number of models operate under limited approaches or are focused on technical or managerial actors, omitting the systematic participation of teachers, students, administrative staff, and other stakeholders.

Finally, the gap analysis highlighted the need for a framework that:

- Integrate multiple critical dimensions of digital transformation.
- Be adaptable to the Latin American context and empirically validated.
- Promote a structured and cross-cutting collaborative approach.

These findings underpin the next step in this research: the design of a Collaborative Digital Transformation Framework for Higher Education Institutions (CDTF). The conceptual model, structuring dimensions, and implementation logic that will guide this framework will be defined below, with an emphasis on its practical applicability and its capacity to strengthen the core processes of a higher education institution such as the Comfacaucá University Corporation – UNICOMFACAUCÁ, located in the department of Cauca, Colombia. This proposal was developed based on gaps identified in the literature and the specific needs of higher education institutions (HEIs), particularly in Latin American contexts such as that of the Comfacaucá University Corporation – UNICOMFACAUCÁ.

This framework seeks to address the challenges identified in previous sections, such as the lack of integration of multiple critical dimensions, the limited participation of institutional stakeholders in digital transformation processes, and the limited applicability of many existing models. In this sense, the MCTD (Model of Digital Transformation and Innovation) is presented as a contextualized, structured, and collaborative solution, aimed at strengthening the core processes of teaching, research, and community outreach through the strategic use of digital technologies.

The MCTD design is based on systems engineering principles, conceptual design methodologies, and participatory approaches, seeking to ensure both technical robustness and institutional relevance. The framework is organized around a set of structuring dimensions, interconnected through a cross-cutting collaborative component, which allows for its flexible adaptation to the specific conditions of each institution. This section first presents the conceptual and methodological foundations of the framework; then describes each of its dimensions and components; and finally, establishes the criteria for its implementation and validation. This development is supported by empirical analysis, expert judgment, and alignment with best practices identified in the previous systematic review.

Components and general structure of the MCTD Framework

The Collaborative Framework for Digital Transformation (CFTD) is structured around a set of components organized under a systemic and adaptive model. Its purpose is to provide practical and conceptual guidance for strengthening digital transformation processes in higher education institutions, integrating critical dimensions and promoting a cross-cutting collaborative approach. Figure 8 describes the structure of the Collaborative Framework for Digital Transformation for Higher Education Institutions (CFTD).

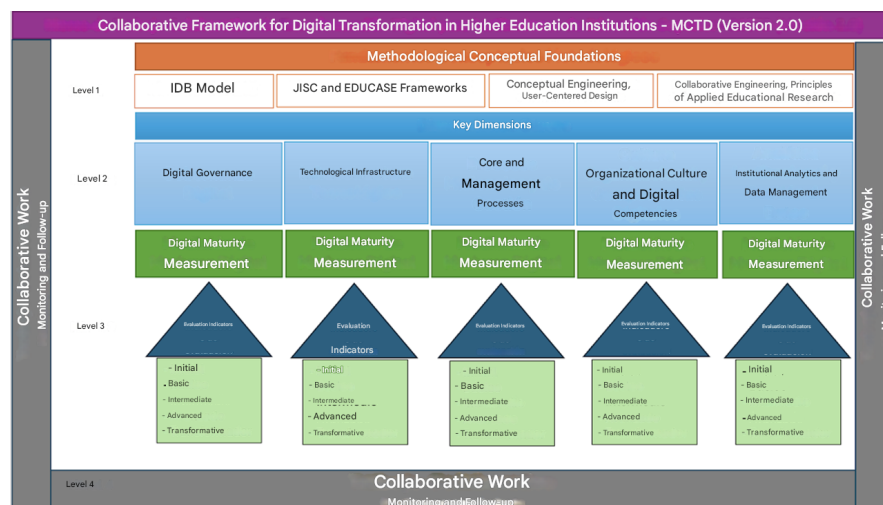


Figure 8: Components and general structure of the MCTD Framework

The MCTD model that has been designed is composed of four levels:

1. The first level includes all the elements of the conceptual and methodological foundations.

- Conceptual: Result of the comparative analysis of internationally recognized conceptual frameworks and standards for measuring and managing digital maturity in higher education. Model adopted from the IDB model with frameworks such as JISC and EDUCAUSE.
- Methodological: Conceptual engineering, user-centered design, collaboration engineering, principles of applied educational research.

2. The second is composed of a Digital Maturity Measurement Process (DMP) for each dimension, which will be used to establish the index or level of digital transformation maturity of each university.

3. The third includes the analyzed evaluation indicators of the conceptual foundations that will serve to systematically assess the degree of development of each subdimension, aligned with the maturity levels (Initial, Basic, Intermediate, Advanced, Transformative). This will facilitate placing the institution on a scale of progress.

4. The fourth level is based on the collaborative work component of the entire framework, which is a cross-cutting element as a central axis to carry out a process of digital transformation in sustainable and continuous improvement higher education institutions.

4.6. Risks due to validity

The analysis of digital transformation models must consider certain limitations that can affect their applicability and effectiveness. Among the main risks identified are:

- Bias in study selection : Most of the reviewed studies come from specific contexts, which may limit the generalizability of the findings.
- Difficulty in implementation : Some models require high levels of investment and advanced technical capabilities.
- Lack of continuity : Without a clear institutional policy, digital transformation initiatives may not be sustainable over time.

These risks must be considered when applying any model in universities with limited resources or complex organizational structures.

5. Conclusions and Recommendations

This study goes beyond a traditional systematic review, as its main purpose was to advance the theoretical construction of the Collaborative Framework for Digital Transformation (CFDT) in higher education institutions (HEIs). The literature review was used as a means to identify, compare, and synthesize the main models of digital transformation in order to establish the conceptual foundations of the proposed framework.

The findings show that current digital transformation models in universities focus primarily on measuring digital maturity and technology adoption, while aspects such as data governance, organizational culture, and structured collaboration remain underdeveloped or fragmented. This limitation justifies the need for a more comprehensive and collaborative approach, capable of integrating technological, organizational, and human dimensions around the university's core mission processes.

The theoretical analysis allowed for the definition of six structuring dimensions: governance, infrastructure, organizational culture, academic processes, collaboration, and data analytics, which form the conceptual basis of the MCTD. These dimensions are interrelated through a cross-cutting collaborative component, understood as the axis that facilitates the integration, co -creation, and sustainability of digital transformation processes.

In this sense, the main contribution of this work lies in proposing a preliminary conceptual framework that integrates the perspectives of digital maturity, data governance, and inter-institutional collaboration into a coherent and contextualized structure for Latin American higher education institutions (HEIs). This framework seeks to guide universities toward a sustainable and participatory digital transformation aligned with their core missions of teaching, research, and community outreach.

Finally, it is acknowledged that this study represents a theoretical phase of the ongoing doctoral project, and therefore the next stages will focus on the empirical validation of the MCTD through the application of digital maturity and collaboration measurement instruments in real institutions. This process will allow the framework to be consolidated as a practical tool for diagnosing, planning, and strengthening collaborative digital transformation in higher education.

Acknowledgments. The authors express their deep gratitude to the Colombian Ministry of Science, Technology and Innovation (MinCiencias) for the financial support provided through Call for Proposals No. 933 of 2023, which has been fundamental to the development of this research within the framework of the doctoral training program. This support has enabled the completion of this study, contributing to the advancement of knowledge in Digital Transformation and its application in strengthening the core processes of higher education.

Declaration of interests . The authors declare that there are no financial, commercial, personal, or academic conflicts of interest that may have influenced the results or the interpretation of the data presented in this study.

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