Strategic Framework for Inclusive and Sustainable Digital Transformation in University 5.0

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***Abstract*—The digital transformation of higher education requires more than the adoption of new technologies; it implies a strategic shift towards inclusive, sustainable, and human-centered institutions. This study proposes a conceptual and operational framework to guide universities in their transition towards the University 5.0 model. Based on documentary analysis of 37 scientific articles and a comparative review of leading universities in the WURI, QS, and UI GreenMetric rankings, key trends and critical gaps were identified, such as digital inequality, limited pedagogical personalization, and the absence of sustainability in institutional governance. In response, a framework structured around four strategic pillars is presented: digital infrastructure, inclusive digital pedagogy, equitable access, and sustainability-oriented governance, all articulated from a human-centered approach. The model is deployed in four implementation phases: institutional diagnosis, strategic design, progressive implementation, and continuous evaluation. This approach provides a pragmatic and flexible model for universities seeking to achieve digital innovation without sacrificing equity or sustainability. The University 5.0 model adds further relevance to the academic and policy discussion through connecting the digital transformation with the SDGs and with advocacy for inclusive, ethical, and sustainable education systems. To increase its external validity, the framework was benchmarked for comparisons with high performing institutional models. Additionally, the framework aligns with ISO 20000, ISO 21001, ISO 26000, ISO 30415 and ISO 9001 standards to ensure quality, sustainability, and social responsibility in its implementation.**

***Keywords*—University 5.0, digital transformation, inclusive education, sustainability, human-centered design, benchmarking validation, ISO standards**

I. Introduction

Higher education is evolving towards the University 5.0, a model that seeks to integrate technology, sustainability, and a humanistic approach [1]. In this paradigm, universities must play a strategic role as catalysts of social and digital innovation, adopting flexible structures and promoting collaborative spaces [2].

The relationship between Industry 4.0 and Society 5.0 has generated significant changes in education, allowing Artificial Intelligence (AI), the Internet of Things (IoT), and big data to transform teaching-learning processes [3]. In addition, the COVID-19 pandemic accelerated digitization in higher education, exposing both opportunities and challenges for equitable access and teacher training [4].

Despite the growth in the use of digital technologies in higher education, a gap persists in the literature on how to integrate digital transformation sustainably and equitably [5]. Most existing studies address the implementation of digital tools without considering how they impact equity, inclusion, and student and faculty well-being [6].

One of the main challenges is the digital divide, which limits access to digital education in underprivileged sectors [7]. Also, literacy in AI and emerging technologies has not been effectively addressed in many university programs, hindering efficient adoption [8].

This article proposes an applied framework to guide universities in the implementation of digital transformation and global innovation strategies, ensuring a technological, sustainable, and human-centered approach. The research answers the question: how can universities adopt digital transformation without compromising equity and sustainability?

To address these objectives, a mixed methodology is followed:

- Documentary analysis of literature on digital transformation in higher education and its relationship with sustainability [1].
- Comparative study of universities that have implemented strategies aligned with University 5.0 [9].
- Proposal of a framework based on good practices and scientific evidence on digitalization and sustainability [10].

This work provides a conceptual and applied model that addresses digital transformation in higher education from a holistic approach, considering technological, social, and environmental dimensions [1]. Universities play a key role in regional innovation by fostering knowledge generation, talent training, and collaboration between academia and industry. Studies have shown that the revitalization of higher education significantly boosts regional innovation capacity, especially through the improvement of industrial structures and the promotion of entrepreneurial activities in urban environments [11].

II. Related Work

There has been a great deal of research, in recent years, on digital transformation and innovation in higher education from defining a solid theoretical framework to strategies deployed in universities around the world. This section summarizes the most relevant literature on digital transformation models, and strategies, the relation between digitalization and high education innovativeness, challenges and barriers to digital transformation, the influence of AI on learning, and the role of sustainability in university transformation.

A. Models and Strategies for Digital Transformation

Digital transformation in higher education has been widely discussed in the literature, addressing different approaches to its implementation and evaluation. A key aspect of this transformation is the need for conceptual frameworks to assess the digital maturity of universities. One study proposes a digital maturity model based on the assessment of organizational, pedagogical, and technological competencies, highlighting the importance of a comprehensive strategy for change [12]. Another complementary study highlights the importance of alignment between institutional strategies and technological capabilities for effective transformation [13].

Digital Transformation Maturity Framework for Higher Education

Higher Education Mega and Major Processes	DT Vision, strategy, leadership, and communication (1)	DT Talent, skills, and knowledge (1)	DT Processes, controls, and digital technologies (1)	DT Technology Infrastructure (1)	Approach to understand and communciate with customers (1)	Total by Process
Learningh and Teaching Processes (20)	2	3	1	3	1.5	10.5
Study Program Accreditation (5)	0	0.5	0	1	0	1.5
Teaching processes preperation and reliazition (5)	1	1	0.5	1	0.5	4
Teaching process Assessment (5)	1	1	0.5	1	1	4.5
Student and Teacher Mobility Realization (5)	0	0.5	0	0	0	0.5
Enabling Processes (30)	4.25	4.75	4	5.5	5.5	24
Student Administration Services (5)	0.5	1	0.5	1	1	4
Library Services (5)	1	1	1	1	1	5
Staff provosion and development services (5)	1	1	1	1	1	5
Finance and accounting services (5)	1	1	1	1	1	5
Marketing, sales, and distribution services (5)	0.25	0.25	0	1	0.5	2
Procurement services (5)	0.5	0.5	0.5	0.5	1	3
Research Processes (25)	1	1	1	2	3	8
Research planning (5)	0	0	0	1	1	2
Research preperation (5)	0.5	0.5	0.5	0.5	1	3
research conduct (5)	0.5	0.5	0.5	0.5	1	3
Research outcome monitoring (5)	0	0	0	0	0	0
Research evaluation (5)	0	0	0	0	0	0
Planning and governance processes (25)	3.5	3.5	3.5	3.5	5	19
Organziation management services (5)	1	1	1	1	1	5
Change and business process management (5)	0.5	0.5	0.5	0.5	1	3
Plan development (5)	0.5	0.5	0.5	0.5	1	3
Budget and fund planning (5)	1	1	1	1	1	5
Performance assets (5)	0.5	0.5	0.5	0.5	1	3
Total by DT Requirement	10.75/20	12.25/20	9.5/20	14/20	15/20	61.5/100

Criteria and Score guidelines	
Desire/Ambition	0
Planning and Designing	0.25-.49
Delivering	0.50.74
Harvesting	.75-100

Fig. 1. Digital transformation maturity in higher education.

Fig. 1. [13] presents a maturity framework for assessing digital transformation in higher education institutions. In this table, processes are grouped into four key categories: learning and teaching, enabling processes, research processes, and planning and governance. Each process is evaluated along five dimensions: vision and leadership, talent and knowledge, digital processes, technology infrastructure, and customer focus. The total score of 61.5/100 suggests that the evaluated institution is in a "Planning and Design" phase within the digital transformation process, indicating significant progress, but still with room for improvement in the implementation and consolidation of digitization. In particular, it is observed that enabling processes have the highest score (24/30), suggesting that infrastructure and administrative services have advanced more in digitization compared to other aspects, such as teaching and research.

In this sense, the Universitat Oberta de Catalunya (UOC) has been widely studied as a reference in the implementation of a digital educational model. Its experience shows that online education not only involves the incorporation of technology but also the need for pedagogical and management strategies adapted to this environment [14].

From a historical perspective, the evolution of higher education has moved from elitist systems to mass education models. A retrospective analysis of the last 50 years shows how universities have had to adapt to new challenges in terms of equity, access, and digitization, driven by technological advances and changes in educational demand [15].

B. Innovation and Digitalization in Higher Education

Universities play a key role in innovation ecosystems, acting as generators of knowledge and facilitators of the link between academia and the productive sector. It has been highlighted that innovation in higher education depends not only on scientific research but also on the ability of universities to adapt to the needs of the environment and establish strategic collaborations [16].

In this context, universities have been identified as key players within innovation systems, contributing to the development of new technologies and fostering interaction between academia, industry, and government [17]. A study in Latin America highlights the need to adapt innovation strategies to specific contexts, pointing out that digitalization should be complemented with policies of inclusion and local development [18]. An exemplary case of innovation in higher education is observed at the Southern University of Science and Technology (SUSTech) in China. Despite operating in a rigid regulatory framework, SUSTech has managed to introduce more flexible management structures, encourage internationalization, and promote an industry-oriented research culture. This approach has allowed the university to position itself as a center of academic excellence and technological innovation, demonstrating that even in institutionally consolidated systems, it is possible to generate significant changes through innovative organizational strategies [19].

Finally, the use of advanced technologies, such as Big Data, has been identified as a key factor to optimize decision-making in universities. However, recent studies warn that the adoption of these tools faces barriers such as data fragmentation and the lack of specialists in information analysis, which hinders their effective implementation [20].

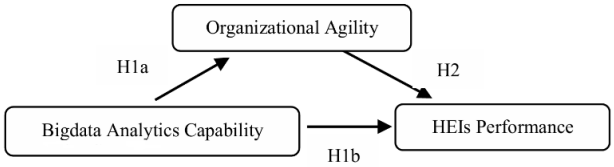

Fig. 2. Big Data Analytics Capability (BDAC) and HEIs research model.

Fig. 2 [20] represents a conceptual model that explores the relationship between Big Data analytics capability (BDAC) and the performance of higher education institutions (HEIs). The model posits three key hypotheses:

H1a: Big Data analytics capability positively influences organizational agility, suggesting that universities with higher data analytics capabilities can better adapt to changes and challenges.

H1b: Big Data analytics capability directly impacts HEIs' performance, indicating that its implementation improves

institutional outcomes.

H2: Organizational agility acts as a mediator in the relationship between BDAC and HEIs' performance, reinforcing the idea that organizational flexibility and responsiveness enhance the benefits of data analytics tools.

From the teaching perspective, various strategies have been explored to transform higher education through innovative methodologies such as project-based learning, gamification, and mentoring. These strategies have proven to be effective in improving the quality of learning and fostering students' active participation in their training [21].

C. Challenges and Barriers to Digitization

Despite advances in digitization, higher education faces significant challenges in terms of equity and inclusion. A study on the readiness of universities for hybrid teaching points out that the main barriers include institutional resistance, lack of technological infrastructure, and insufficient faculty training [22].

Fig. 3. [22] shows the evolution of student enrollment in online and face-to-face programs over 12 years. The graph reflects a structural change in higher education, where online education has gained greater acceptance and participation compared to face-to-face programs. Factors such as technological advancement, the flexibility of digital learning, and the global pandemic have been key drivers of this change.

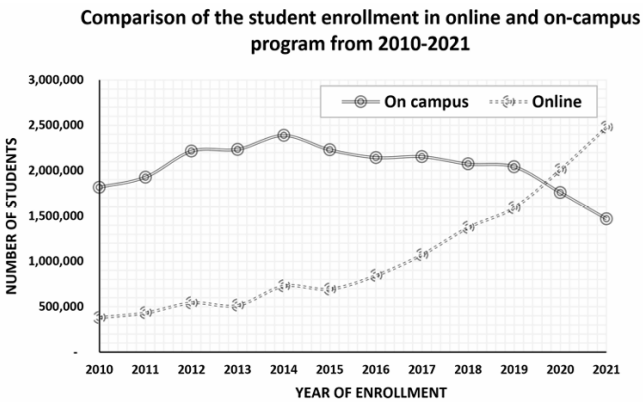

Fig. 3. Increase in online course enrollment compared to on-campus enrollment from 2010 to 2021.

In the case of Portugal, additional problems have been identified related to the scarcity of digital infrastructure and lack of technical support, which limits the effective implementation of educational innovations [23]. Similarly, in India, the adoption of Information and Communication Technologies (ICT) in higher education has faced difficulties due to socioeconomic inequalities and limitations in teacher training [24].

Moreover, the implementation of new technologies does not always translate into effective adoption. A study on the diffusion of technological innovations in universities points out that the lack of change strategies and resistance to the use of new tools can significantly delay the digitization of institutions [25].

The COVID-19 pandemic accelerated the digitization of higher education but also exposed structural challenges. An analysis of strategies implemented during the health crisis shows that many universities adopted hybrid models without adequate prior planning, leading to problems in terms of access to technology and faculty training [26].

D. Artificial Intelligence and Education

The use of Artificial Intelligence (AI) in higher education has raised both expectations and concerns. A study conducted in Kuwait found that students have a mostly positive perception of AI in education, although concerns persist about costs, privacy, and complexity in its implementation [27].

In Latin America, the adoption of AI in universities has been analyzed from the perspective of its impact on technological infrastructure and teacher training. Studies suggest that, although these technologies can improve learning personalization and operational efficiency, their implementation still faces significant barriers [28].

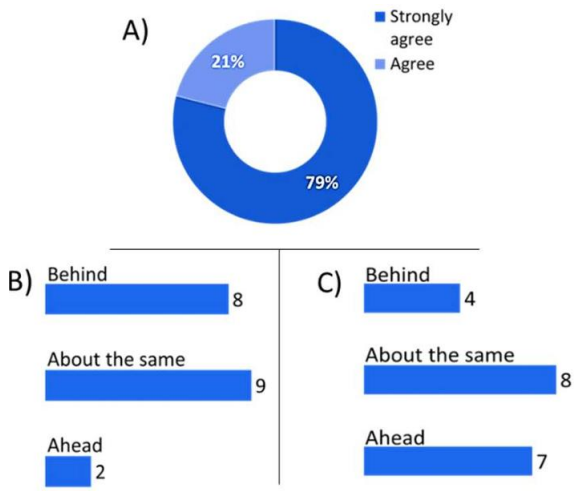

Fig. 4. Percepcion sobre la implementacion de IA en educación superior.

Fig. 4 [28], shows participants' opinions on the importance and status of artificial intelligence (AI) implementation in higher education institutions, which describe the following results:

Importance of AI: The majority of respondents consider AI implementation to be crucial for the future of their institutions, with 79% "strongly agreeing" and 21% "agreeing".

Comparison with the corporate world: Responses show that 8 respondents believe that higher education is "behind" the corporate sector, 9 believe they are "at the same level", and only 2 believe they are "ahead".

Status of implementation at their institutions: In assessing their own universities, 4 respondents believe they are "behind" in AI adoption, 8 believe they are "at the same level," while 7 believe their institutions are "ahead" in AI implementation.

The results suggest that while most recognize the importance of AI in higher education, there is a widespread perception that its adoption still faces challenges compared to the corporate sector. In addition, the assessment varies by institution, indicating different levels of progress in implementing AI-based solutions.

From a global perspective, the adoption of AI in higher education continues to show a considerable gap between institutions with access to advanced technological resources and those that lack the necessary conditions for its effective implementation. The availability of infrastructure, access to quality data, and the training of specialized personnel are

critical factors that determine the viability of these solutions [27, 28].

E. Sustainability and Higher Education

Another fundamental aspect in the transformation of higher education is sustainability. The literature emphasizes that universities should integrate the Sustainable Development Goals (SDGs) into their curricula and organizational culture. Education has been identified as playing a key role in promoting sustainable development, with impacts on poverty reduction, gender equity, and improved quality of life [29].

Digital transformation and innovation in higher education are critical issues in the current context, where universities face the challenge of integrating advanced technologies and sustainable approaches to improve management and educational quality. Costa and Cipolla [30] highlight the importance of soft skills, such as communication, collaboration, and emotional management, to foster sustainable and holistic education in higher education. These skills are essential to address socio-environmental challenges and promote a culture of peace and cooperation in educational institutions. On the other hand, Mattos *et al*. [31] emphasizes the need for effective management models, such as the Baldrige Excellence Model, to improve efficiency and sustainability in university management. This model, which includes criteria such as leadership, strategic planning, and transparency, has proven to be effective in aligning university processes with sustainability and quality objectives. Both studies highlight the importance of integrating human-centered and sustainability approaches to achieve effective digital transformation in higher education.

Fig. 5. [30] shows a three-phase approach: immersion, content analysis, and synthesis. The research begins with a literature review on soft skills and educational practices, complemented with documentary research. Then, a coding process is carried out to analyze the content and extract relevant information. In the synthesis phase, critical soft skills for sustainability are identified using tools such as idea cards and affinity diagrams. Finally, the research question is posed: How can critical soft skills for sustainability be integrated into higher education? This methodological framework allows for a structured analysis to understand and promote these skills in university education.

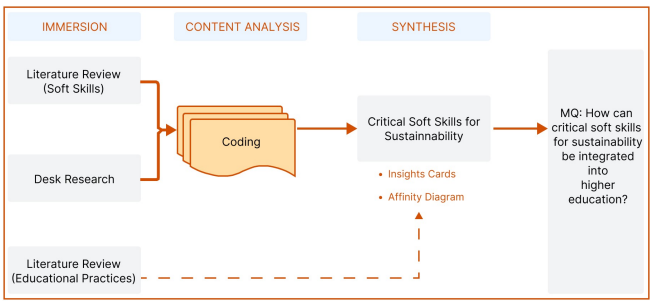

Fig. 5. Methodological framework of this research.

In conclusion, the literature reviewed shows that digital transformation in higher education involves not only the adoption of new technologies but also a strategic rethinking of educational models, the integration of sustainability and equity, and collaboration with industry to strengthen innovation ecosystems.

III. Methodology

This research adopts a mixed methodology combining documentary analysis, comparative study, and development of an applied framework. This approach was designed to answer the central question of the study: How can universities adopt digital transformation without compromising equity and sustainability?

The sources of information were obtained through a systematic search in indexed academic databases such as Scopus, IEEE Xplore, and Web of Science, considering publications between 2020 and 2024, following criteria of methodological quality, accessibility, and thematic relevance.

A. Documentary Analysis

A systematic literature review was applied as the basis for the documentary analysis, structured in three phases: planning, execution, and reporting, following the methodological model proposed by Ramadania *et al*. [32]. More than 180 articles addressing digital transformation in higher education and its relationship with organizational performance, sustainability, and equity were retrieved. Keyword co-occurrence visualization tools were used to identify five predominant thematic areas: digital education, sustainability, teaching-learning, technological innovation, and digital competencies.

This phase allowed the conceptual foundations of the study to be established and guided the design of the framework, ensuring that it was aligned with global trends and identified research gaps.

B. Comparative Study

The study consisted of selecting the Top 5 universities from three complementary international rankings: WURI 2024 (focused on innovation and social impact), QS World University Rankings 2024 (focused on academic excellence), and UI GreenMetric 2024 (oriented to institutional sustainability). This methodological approach was inspired by the comparative approach used by Muñoz-Suárez *et al*. [33], who analyze the intersections between academic and environmental rankings. The three sources were grouped to form a total sample of 15 globally recognized universities. This selection allowed for comparing real initiatives aligned with the University 5.0 model, integrating criteria of educational innovation, digital transformation, equity, and commitment to the Sustainable Development Goals (SDGs).

To complement the traditional analysis focused on academic performance (QS) and environmental sustainability (GreenMetric), the WURI 2024 ranking was incorporated, which prioritizes the capacity of universities to generate innovation with real impact. Given that the University 5.0 model integrates dimensions such as institutional creativity, social responsibility, and transformational leadership, this inclusion allows for a more holistic vision aligned with the principles of the study.

C. Proposal of a Framework

The third methodological phase consisted of the conceptual design of a framework for sustainable digital transformation in the University 5.0, built from the previous documentary and comparative analysis. This model proposes a strategic architecture of four interdependent pillars: digital

infrastructure, inclusive digital pedagogy, equitable access, and sustainability-oriented governance, all articulated from a human-centered approach. This centrality implies that institutional decisions, the use of emerging technologies, and pedagogical innovation must be aligned with principles of well-being, inclusion, ethics, and equity.

The framework is organized operationally in four dynamic phases:

- Institutional diagnosis: assessment of the level of digital maturity, inclusion, and institutional capabilities.
- Strategic design: participatory planning with indicators, objectives, and transformation paths.
- Progressive implementation: gradual deployment of actions, technologies, and active methodologies.
- Continuous evaluation: systematic monitoring, feedback, and iterative improvement of results.

This model is partially inspired by previous frameworks such as Hasan *et al*. [34] but transcends them by incorporating new dimensions such as sustainable governance, stakeholder participation, integrated operational phases, and human-centered systemic visualization.

Likewise, the framework is strengthened by recent contributions from the international literature, such as:

- Genga & Babalola [35]: whose approach highlights digital transformation anchored in a green institutional culture, inclusive and sustained by equity policies.
- Pachava *et al*. [36]: propose an ethical framework for the use of generative artificial intelligence, with emphasis on personalization of learning and educational justice, aligned with SDG 4.
- Osorio *et al*. [37]: develop a qualitative methodology to prioritize institutional actors in university innovation processes, linking governance with the principles of Society 5.0.

D. Benchmarking-Based Validation

In order to provide evidence of the consistency and practical feasibility of the proposed framework, a benchmarking-based validation strategy was incorporated. This technique is supported by previous works in the field of educational innovation, where benchmarking serves as a systematic tool to compare models, extract best practices, and improve framework components through critical reflection and contextual alignment [38, 39].

The validation procedure was structured in three stages:

- Benchmarking Planning: The first step consisted of defining the validation scope, identifying comparable frameworks in the higher education sector that address sustainability, digital transformation, or inclusive governance. The selection was based on availability of public documentation, institutional reports, or peer-reviewed literature. A validation matrix was developed to identify convergences and divergences across components (pillars, strategies, indicators).
- Framework Comparison and Mapping: The second step involved applying benchmarking criteria such as *performance indicators*, *strategic alignment*, *stakeholder inclusion*, and *continuous evaluation mechanisms*. This was inspired by the analytical schemes proposed in educational quality assurance research [38] and municipal benchmarking in public service delivery [39]. The data collected allowed contrasting the pillars and KPIs of the proposed framework with those from high-performing models in similar contexts.
- Synthesis and Improvement Suggestions: Based on the comparison, a gap analysis was conducted to identify potential weaknesses and opportunities for enhancement in the original framework. The insights from this process informed the refinement of implementation phases and the extension of sustainability and inclusion indicators within the scorecard.

This benchmarking-based validation strengthens the external consistency and relevance of the framework and complements the conceptual and empirical components developed through systematic review and case analysis. The specific results of this comparative analysis—summarized through a visual benchmarking matrix—are presented in the Results section to highlight key strengths and improvement opportunities identified during the process.

IV. Results

A. Results of the Documentary Analysis

The documentary analysis was based on a systematic review of 37 scientific articles selected for their relevance in issues of digital transformation, educational innovation, and sustainability in higher education. Additionally, other bibliographic sources were used to complement the conceptual framework, methodological justification, and alignment with the Sustainable Development Goals (SDGs). This analysis identified the main thematic trends in Table 1, which emerge most frequently in the literature, allowing us to draw a clear map of the current state of knowledge in the area.

Table 1. Key thematic trends identified in the literature review

Key Theme	Approximate Frequency of Appearance
Digital transformation	34
Sustainability in higher education	22
Digital equity and inclusion	18
Digital and soft skills	20
Artificial intelligence in education	19
Institutional governance and leadership	14
Innovation in university ecosystems	16
Hybrid models and online learning	15
Use of Big Data and learning analytics	13
Digital divide and technological challenges	17

This analysis shows that digital transformation is the dominant theme, followed by concerns associated with sustainability, the development of key competencies, and the need for equity in access to educational technologies. The growing attention to artificial intelligence (AI) in university contexts highlights its transformative potential but also reveals challenges related to infrastructure and training.

Despite the growing body of literature on these topics, there are important gaps that justify the need for a specific framework. These include the absence of comprehensive models that simultaneously articulate technology, sustainability, and equity; the scarce evidence on practical

implementation in low-income universities or outside the northern hemisphere; the limited integration of soft skills in digital transformation frameworks; and the still fragmented approaches to university digital governance.

B. Comparative Study

For the comparative study, we selected the top five universities from each of the three global rankings:

- WURI 2024 (focused on real innovation and social impact),
- QS World University Rankings 2024 (emphasizing academic reputation and research excellence), and
- UI GreenMetric 2024 (highlighting sustainability and environmental responsibility).

This selection offers a comprehensive and diversified view of how top-performing institutions are advancing digital transformation, ethical governance, and sustainability in higher education. By analyzing their concrete initiatives aligned with the University 5.0 model, this study identifies patterns, complementarities, and best practices that contribute to the conceptual and practical foundation of the proposed framework.

Table 2 presents the five top-ranked universities in the WURI 2024: Global Top 300 Innovative Universities ranking, a list that prioritizes real innovation and social impact over traditional indicators. All the institutions in the Top 5 belong to the United States and stand out for their disruptive teaching-learning models, application of technology, collaboration with industry, and commitment to sustainable development.

Table 2. Top 5 institutions from WURI 2024: Global top 300 innovative universities [40]

Rank	University	Country
1	Minerva University	United States
2	Arizona State University	United States
3	Massachusetts Institute of Technology (MIT)	United States
4	University of Pennsylvania	United States
5	Stanford University	United States

This approach is directly aligned with the principles of the University 5.0 model, by placing pedagogical innovation, the strategic use of emerging technologies such as artificial intelligence, and institutional adaptability in the face of global challenges at the center. The presence of universities such as Minerva University recognized for its student-centered educational structure, or Arizona State University, a leader in technological integration with social impact, reinforces the validity of the framework proposed in this study and its applicability to diverse contexts.

Table 3 presents the five top-ranked universities in the QS 2024 ranking, recognized for their focus on academic excellence, global reputation, scientific production, and institutional impact. These institutions were selected for their leadership in research, educational innovation, and digital transformation, key aspects of the University 5.0 model.

Table 4 includes the five top-ranked universities in the UI GreenMetric 2024 ranking, which evaluates institutions' commitment to environmental sustainability, resource efficiency, and green policies. These universities represent institutional models with a strong ecological focus and social responsibility, fundamental components of sustainable higher education.

Table 3. Top 5 Qs world university rankings 2024 [41]

Rank	University	Country
1	Massachusetts Institute of Technology (MIT)	United States
2	University of Cambridge	United Kingdom
3	University of Oxford	United Kingdom
4	Harvard University	United States
5	Stanford University	United States

Table 4. Top 5 UI GreenMetric world university rankings 2024 [42]

Rank	University	Country
1	Wageningen University & Research	Netherlands
2	Nottingham Trent University	United Kingdom
3	University of Nottingham	United Kingdom
4	Universitas Indonesia	Indonesia
5	University of Groningen	Netherlands

Table 5 presents the 15 leading universities selected from the WURI 2024, QS World University Rankings 2024, and UI GreenMetric 2024 rankings, highlighting their real-world initiatives aligned with the University 5.0 model. These initiatives span areas such as digital transformation, human-centered pedagogical strategies, ethical use of artificial intelligence, and institutional sustainability. The comparison of these institutions allows for the identification of complementary approaches and best practices that inform the design of the framework proposed in this study. Including innovation-oriented rankings such as WURI reinforces the relevance of institutional adaptability, while QS and GreenMetric emphasize excellence and environmental responsibility, respectively—together providing a well-rounded global perspective on the evolving role of higher education.

The comparative analysis between leading universities in educational innovation (Table 2), academic excellence (Table 3), and institutional sustainability (Table 4) shows how different dimensions of university transformation are manifested in different contexts. The universities highlighted in the WURI 2024 ranking, such as Minerva University or Arizona State University, focus on curricular innovation, active learning, and real social impact, promoting disruptive models that reconfigure the university experience.

Universities in the QS 2024 ranking, such as MIT, Cambridge, or Harvard, reinforce their leadership by developing capabilities in scientific research, advanced digital transformation, and artificial intelligence applied to education, consolidating highly competitive and technologically sophisticated environments.

For their part, the institutions highlighted in the UI GreenMetric 2024, such as Wageningen University, Groningen or UC Davis, integrate environmental sustainability as a transversal axis of their management, curriculum and institutional culture, developing smart campus models and university policies aligned with the SDGs.

Looking at the University 5.0 initiatives of these 15 institutions together (Table 5), convergent and complementary approaches are identified. While some universities prioritize digitalization and the development of emerging technologies, others have managed to institutionalize values such as equity, participation, and sustainability.

Table 5. University 5.0 initiatives

Item	University	Country	University 5.0 Initiative[1]
1	Minerva University	United States	Active learning model with global immersion experiences, fostering critical thinking, adaptability, and human-centered education.
2	Arizona State University (ASU)	United States	"ASU Sync" hybrid model combining in-person and real-time remote learning to increase accessibility and inclusion.
3	Massachusetts Institute of Technology (MIT)	United States	"MIT OpenCourseWare" offers free global access to course materials, promoting open, lifelong learning.
4	University of Pennsylvania (UPenn)	United States	"Penn Compact 2022" focuses on inclusion, innovation, and impact through integrated tech and equity in education.
5	Stanford University	United States	"Stanford Online" platform delivers flexible, high-quality digital education for continuous learning.
6	University of Cambridge	United Kingdom	"Cambridge Centre for Teaching and Learning" promotes innovative pedagogy and digital integration in classrooms.
7	University of Oxford	United Kingdom	"Oxford AI Society" fosters ethical application and research of AI across disciplines.
8	Harvard University	United States	"Harvard Innovation Labs" support student ventures and interdisciplinary innovation with social impact.
9	California Institute of Technology (Caltech)	United States	"Caltech CTLO" (Center for Teaching, Learning & Outreach) promotes evidence-based teaching and educational technology.
10	Imperial College London	United Kingdom	"Edtech Lab" designs tech-based solutions to enhance teaching effectiveness and student engagement.
11	Wageningen University & Research	Netherlands	"Green Office Wageningen" is a student-led sustainability platform that promotes eco-conscious policies campus-wide.
12	University of Nottingham	United Kingdom	Comprehensive "Sustainability Strategy" integrated into operations, curriculum, and research initiatives.
13	University of Groningen	Netherlands	"Green Office Groningen" engages staff and students in sustainable campus innovation projects.
14	Nottingham Trent University	United Kingdom	"Sustainable Development Team" reduces carbon footprint and promotes education for sustainable development.
15	University of California, Davis (UC Davis)	United States	"UC Davis Sustainability Initiative" integrates research, education, and operations to address global environmental challenges.

[1]The initiatives listed in Table 5 were extracted and paraphrased from the official websites of each university, consulted between February and March 2025. They represent real institutional actions aligned with the University 5.0 model.

This contrast reveals that academic excellence, real innovation, and environmental sustainability do not always coexist in an integrated manner, which reinforces the need for strategic frameworks that articulate these dimensions under an integral approach. The best practices observed in these universities constitute a key input for the design of the framework proposed in this study, which seeks to align technology, sustainability, and human inclusion as fundamental pillars of the University 5.0 model.

C. *Proposed University 5.0 Framework*

The evidence gathered in the documentary and comparative analysis leads to the conclusion that, although many universities have made significant progress in digitization, sustainability, and pedagogical innovation, these transformations tend to be implemented in isolation, with little strategic articulation. In turn, human dimensions such as well-being, equity, or participation often lag behind technological or institutional reputational interests.

In response to this gap, an applied and adaptable framework is proposed that articulates four key dimensions - infrastructure, pedagogy, access, and governance - with a central human-centered core, and an operational structure based on phases of continuous improvement. This model is aligned with the principles of University 5.0, which is understood as a transformative, digital, sustainable, and inclusive institution committed to integral human development.

Fig. 6. Framework University 5.0. The proposed model is structured from a central core called the "Human-Centered Core", which represents the comprehensive approach of the University 5.0 towards equity, well-being, inclusion, and ethics. This core is connected to four strategic pillars (blue circles):

- Digital Infrastructure: scalable technologies, interoperability, and connectivity for learning.
- Inclusive Digital Pedagogy: learner-centered, accessible, and personalized pedagogical models.
- Equitable Access: actions to reduce digital divides and ensure educational inclusion.
- Sustainability-oriented governance: institutional policies with a sustainable, participatory vision aligned with the SDGs.

Each pillar is activated through operational phases (green circles), which are part of a dynamic cycle of institutional transformation:

- Institutional Diagnosis (initial assessment of digital capabilities and sustainability).
- Strategic Design (collaborative planning with indicators and innovation).
- Progressive Implementation (phased implementation of solutions),
- Continuous Evaluation (monitoring and feedback based on results).

The continuous arrows indicate the direction of conceptual influence from the core to the pillars, while the dotted arrows represent the operational links between pillars and phases. Each arrow includes a functional label describing its purpose (e.g., Technology for People, Inclusive Design Process, Equity & Inclusion), thus reinforcing the systemic coherence of the model. The explicit integration of the SDG icons in each pillar highlights the alignment of the entire framework with the United Nations Sustainable Development Goals, reinforcing its educational and social relevance globally.

Structure of the model: the framework is composed of four interdependent strategic pillars shown in Table 6:

Table 6. Framework Pillars

Strategic Pillar	Description
Digital Infrastructure	Scalable platforms, universal connectivity, and system interoperability.
Inclusive Digital Pedagogy	Flexible curricula, active learning methodologies, accessibility, and student well-being.
Equitable Access	Bridging the digital divide, continuous training, and affordable technologies.
Sustainability-Oriented Governance	Institutional policies aligned with the SDGs, with student and faculty participation.

Implementation phases: To ensure its effective application, the model is organized into four dynamic phases:

- **Institutional Diagnosis:** Assessment of the level of digital maturity, inclusion, sustainability, and internal capabilities. This phase is aligned with ISO/IEC 20000 (IT service management) and ISO 21001 (educational organizations), reinforcing a structured evaluation of digital and organizational readiness.
- **Strategic Design:** Co-creation of objectives, indicators, and action paths with the participation of key stakeholders. It is supported by ISO 26000, which provides guidance on social responsibility and ensures inclusive stakeholder involvement.
- **Progressive Implementation:** Deployment in stages, including pilots, teacher training, and process adjustment. It incorporates principles of ISO 9001, ensuring quality management and continuous process improvement throughout implementation.
- **Continuous Evaluation:** Monitoring with indicators of academic, social, and environmental impact, with active feedback. This phase integrates ISO 21001 and ISO 30415 to ensure ongoing assessment aligned with educational quality and diversity, equity, and inclusion (DEI) principles.

Visualization of the model: The model is represented by a circular scheme, in which the human being is located in the center, surrounded by the four strategic pillars, and activated by an external ring of operational phases. This configuration reinforces the systemic and humanistic vision of the proposed framework.

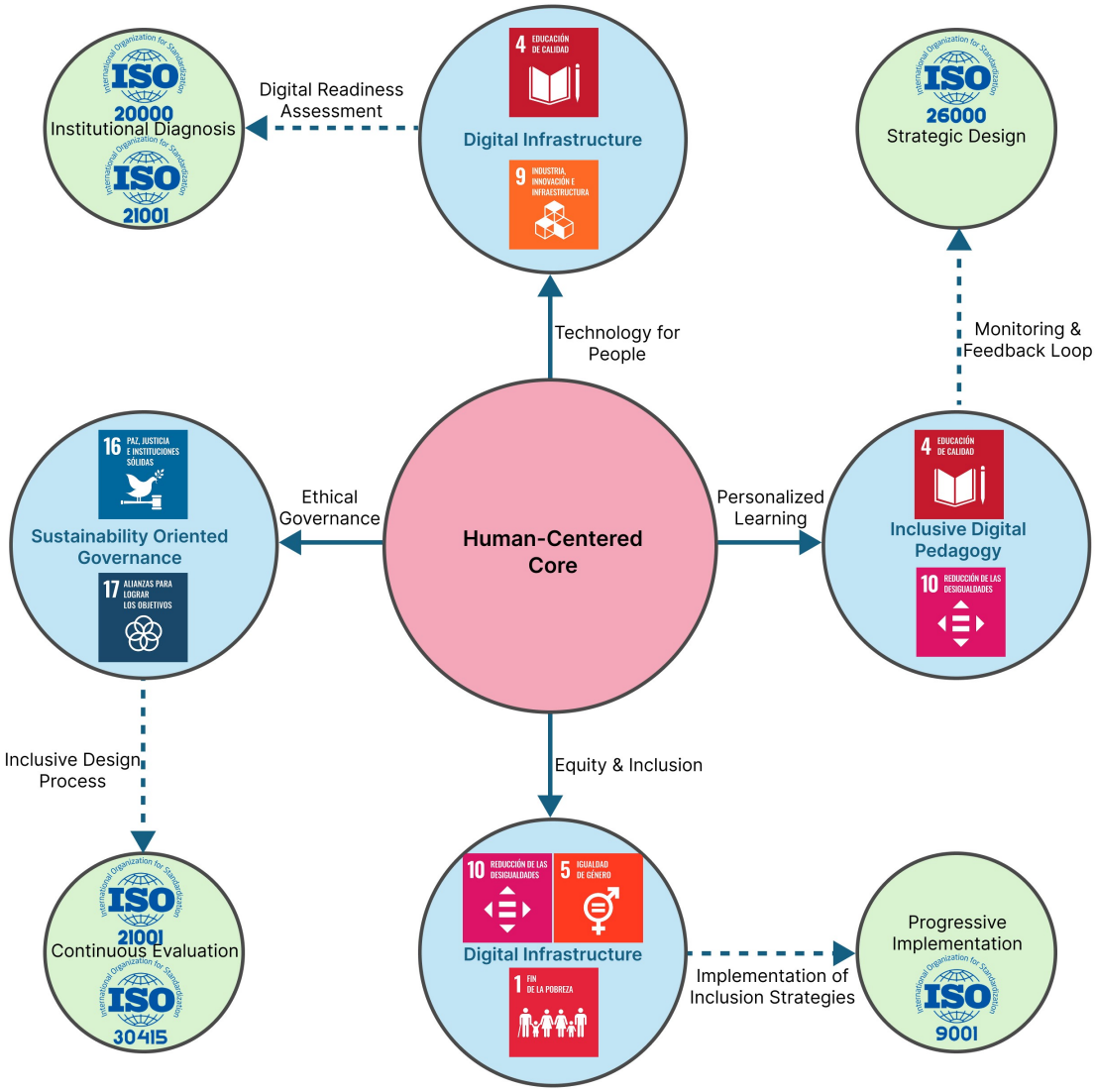

Fig. 6. Proposed University 5.0 framework.

Table 7 presents a strategic assessment matrix that operationalizes the conceptual framework proposed in Fig. 6, entitled Strategic Framework for Human-Centered Digital Transformation in Higher Education. This figure defines four fundamental strategic axes that guide university digital transformation from a people-centered perspective and are

aligned with the Sustainable Development Goals (SDGs): (1) Digital Infrastructure, (2) Inclusive Digital Pedagogy, (3) Equitable Access, and (4) Sustainable Governance.

Each of these axes has been disaggregated in Table 7 according to five evaluative dimensions: vision/strategy, infrastructure, culture/competencies, enabling technology (with emphasis on the use of generative artificial intelligence such as ChatGPT), and indicators/KPIs.

These dimensions allow transforming the conceptual framework into a diagnostic and strategic planning tool, applicable to various higher education institutions. The intersections of the matrix describe examples of policies, practices, and technologies that a university could adopt or monitor to advance each axis of transformation.

Table 7. Strategic assessment matrix for human-centered digital transformation in higher education

Dimension / Criterion	Digital Infrastructure	Inclusive Digital Pedagogy	Equitable Access	Sustainability-Oriented Governance
Vision / Strategy	Alignment of institutional objectives with ICT development plans	Adaptive instructional design centered on student needs	Policies on digital inclusion and sustainability	Integration of the SDG framework into institutional vision
Infrastructure	Interoperability, connectivity, and platform availability	Accessible platforms, LMS integrated with inclusive tools	Provision of subsidized devices and connectivity	Green technology, energy-efficient data center infrastructure
Culture / Competencies	Technical training for administrative and teaching staff	Faculty competencies in instructional design and inclusive digital resources	Digital literacy training for disadvantaged student populations	Promotion of a sustainability-driven and ethically responsible institutional culture
Enabling Technology (AI)	Use of AI for institutional system monitoring and data analytics	Use of ChatGPT for personalized content generation and formative feedback	Use of ChatGPT as a tutoring assistant for students with cognitive or language barriers	AI applied to environmental impact measurement and operational efficiency
Indicators / KPIs	% of digital services with universal accessibility compliance (WCAG), % of energy-efficient devices deployed	% of faculty trained in inclusive design, % of students with IEPs (Individualized Education Plans) reached	% of access gap reduction in rural/low-income zones, % of students accessing devices via public subsidies	Carbon footprint per enrolled student (tons CO_2 eq.), % of institutional procurement aligned to SDGs

Notably, the dimension of enabling technologies includes the use of generative artificial intelligence tools - such as ChatGPT - to enhance teaching-learning processes, digital inclusion, and institutional efficiency. These technologies are increasingly being adopted by teachers for lesson planning, multilingual content creation, formative feedback and personalized student support. Their integration reinforces the people-centered orientation of the proposed framework, positioning AI not as a replacement, but as a strategic ally in line with the principles of University 5.0.

Overall, Table 7 provides a structured basis that can serve both for institutional self-assessment and for the planning of interventions aimed at a sustainable, inclusive and people-centered digital transformation.

D. *Benchmarking-Based Validation Outcomes*

To evaluate the external relevance and consistency of the proposed University 5.0 framework, a benchmarking analysis was conducted using five key comparison criteria. Table 8 presents a visual benchmarking of internationally recognized educational frameworks—UOC (CRISS), Stanford, and MIT Sloan (CISR)—against the University 5.0 proposal.

Each row reflects a critical dimension for educational innovation and governance, while the use of color-coded indicators allows for intuitive interpretation:

🟢 Green indicates full alignment or presence of the element in the institution's model;

🟡 Yellow denotes partial or emerging implementation;

🔴 Red signifies a lack of public evidence or absence of the element.

Visual comparison shows that the University 5.0 model incorporates all criteria in an integrated way while the others have different status of maturity. Areas such as SDG alignment and ISO/quality standards are not very well developed in one of the benchmarked models reflecting the advanced innovative nature of the University 5.0 proposal.

Table 8. Comparative matrix of framework elements across institutions

Key Criteria	[43] UOC (CRISS)	[44] Stanford	[45] MIT Sloan (CISR)	University 5.0 Proposal
Digital Competencies	🟢	🟡	🔴	🟢
Inclusion / DEI	🟡	🟢	🔴	🟢
Structured Implementation Cycle	🟡	🟢	🟡	🟢
Alignment with SDGs	🔴	🟡	🟡	🟢
Standards (ISO/Quality Frameworks)	🟡	🔴	🟡	🟢

V. Conclusions

This research addressed the central question: How can universities adopt a digital transformation without compromising the principles of equity and sustainability? The findings indicate that such a transformation is only viable when conceived as a strategic, comprehensive, and human-centered process that transcends the mere adoption of technologies.

To support this premise, a University 5.0 conceptual framework was developed, structured around four strategic pillars: digital infrastructure, inclusive digital pedagogy, equitable access, and sustainability-oriented governance. These pillars are operationalized through four adaptable implementation phases: institutional diagnosis, strategic design, progressive deployment, and continuous evaluation.

As part of the validation strategy, this study incorporated a

benchmarking-based approach, comparing real-world initiatives from globally recognized universities. The resulting comparative matrix serves as a valuable reference for institutions seeking to guide their digital transformation efforts based on inclusive, sustainable, and best-practice-driven principles. Furthermore, the integration of international standards—such as those incorporated in the proposed framework (Fig. 6), including ISO 21001 (educational management), ISO/IEC 20000 (IT service management), ISO 26000 (social responsibility), ISO 30415 (diversity and inclusion), and ISO 9001 (quality management)—reinforces the model's applicability and alignment with quality assurance and governance frameworks in higher education.

The results demonstrate that deep and meaningful digitalization is possible without sacrificing equity or social responsibility—provided that institutional decisions are guided by ethical, inclusive, and sustainability-driven values.

The main contribution of this research lies in offering a structured, flexible, and actionable framework that enables universities to redesign their internal processes in alignment with 21st-century challenges and the Sustainable Development Goals (SDGs).

A key limitation of this study is the geographical bias in the selection of benchmarked institutions, which are predominantly based in the Global North. While this was due to the availability of publicly documented frameworks, future studies are encouraged to include universities from the Global South to assess the model's adaptability and cultural relevance across diverse educational contexts.

VI. Future Work

Future research may explore integrating the University 5.0 framework with immersive environments like the metaverse, assessing its impact on personalized learning, student engagement, and digital inclusion. It is also relevant to examine cybersecurity and cyberbullying prevention as essential components of ethical governance in virtual contexts.

Another promising line of inquiry involves the model's adaptation through inter-institutional alliances, particularly in the Global South. A notable case is the Universidad Peruana de Ciencias Aplicadas (UPC), the first Peruvian university to adopt Minerva University's educational methodology. This collaboration illustrates the contextualized transfer of disruptive models and offers a reference for scaling digital transformation in a sustainable and human-centered manner.

Finally, although this study acknowledges the potential of generative AI tools like ChatGPT to accelerate digital transformation, future work must critically address limitations such as algorithmic bias, unequal access, and ethical concerns around data privacy and student agency. Ensuring that AI-driven innovations align with the human-centered ethos of University 5.0 remains a vital challenge.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

J.C.M.A. led and carried out the research, conceived and developed the conceptual framework, designed and structured the proposed framework for University 5.0, conducted the documentary analysis, reviewed comparative case studies, and wrote the main text of the manuscript. E.H.M.L. provided academic support, assisted with the critical review of the literature, and offered suggestions for strengthening the research methodology. L.F.L.V. contributed his experience as an external expert, critically reviewed the manuscript, and provided specific recommendations on the incorporation of emerging technologies in higher education. All authors reviewed and approved the final version of the manuscript.

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