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Digital transformation model for universities: A preliminary proposal

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ABSTRACT

This article presents the results of a research project aimed at designing a theoretical model for digital transformation at the Autonomous University of Chile. The research methodology adopts a case study approach with a mixed method combining quantitative and qualitative techniques. This approach provides a nuanced and comprehensive understanding of the dimensions and factors shaping the digital transformation model, incorporating insights from 97 students and eight experts. The model comprises three phases, nine dimensions, and 54 indicators, emphasizing the integral connection between digital maturity and value creation for students. Key success determinants in the university's digital transformation processes are outlined, including the strategic approach, organizational culture, utilization of technological infrastructure, and technology management capabilities. Practical implications underscore the significance of acknowledging the impact of power relations during the digital transformation journey, influencing internal processes, IT governance coordination, roles of personnel in technical and managerial positions, teachers' performance, and students' trust and loyalty to the institution. The article concludes by identifying factors that influence the institution's capacity to implement technological changes aligned with its strategic, technical, and logistical requirements. Future studies could redefine the roles of administrative, teaching, and student staff, fostering increased digital maturity, continuous innovation in services and processes, and the creation of new digital learning spaces centered around student needs.

Contribution/Originality: The originality of this study lies in its design of a specific digital transformation model for a Chilean university using structural equations for the first time. It addresses a gap in the literature concerning the empirical approach to digital transformation in higher education institutions in Latin America.

1. INTRODUCTION

The value offered by information technology in a society based on the knowledge economy has been studied from the perspective of the profitability that could be obtained by implementing a technological infrastructure in a certain organization until reaching digital transformation through the establishment of relationships between the strategy, structure, and technology to respond assertively to the challenges posed by a digital environment (Drechsler, Gregory, Wagner, & Tumbas, 2020). This evolution implies the adoption of strategic thinking oriented toward innovation, not only in terms of products and services, but also in terms of the interactions that occur

between users and technology, which impacts finances, the processes of value creation, the way of using technological resources and the organizational structure itself (Matt, Hess, & Benlian, 2015).

In the context of higher education, which shows different characteristics from other industrial and service sectors, figures have not yet been found that elucidate the success rate of digital transformation projects (Catlin, Scanlab, & Willmott, 2015) but it is known that this transformation process it has not kept up with the pace of change that society has been experiencing (Rodríguez-Abitia & Bribiesca-Correa, 2021). It has not even been an obeyed university strategy but, on the contrary, it has been a discretionary power of teachers that has not been accompanied by any type of support from the university. In addition, it has been argued that one of the great challenges facing universities is represented by generational differences between digital native students and faculty (Balyer & Öz, 2018), inadequate leadership, organizational culture that is resistant to change, poor planning for digitization and unavailability of the financial resources necessary to execute the plans (Rodríguez-Abitia & Bribiesca-Correa, 2021). Even if the development of a specific set of digital capabilities leads to a greater digital maturity, there is a whole conceptual base and model to evaluate the effectiveness of digital transformation efforts in companies (Castro, Tamayo, Burgos, & Martens, 2022) but there is still no measurement framework for digital maturity in academic work (Rossmann, 2019).

Knowledge management is a strategic factor for the digital transformation of universities (Ramírez-Montoya, 2020) and cannot be subject to the temporality of a specific crisis, such as the Covid-19 pandemic, or the simple acquisition of technological platforms to support academic processes. It refers to the adoption of profound cultural changes accompanied by new management, teaching, and innovation models in their organizational, technological, and sociocultural dimensions (Castro et al., 2022).

In the context of higher education institutions, digital transformation is a deep and accelerated transformation of processes, skills and models to make the most of the changes and opportunities offered by digital technologies (Demirkan, Spohrer, & Welser, 2016). It is also viewed as a management process that guides the culture, strategy, methodologies, and capabilities of an organization based on the use of digital technologies (Crespo & Pariente, 2018) and as a process of change, disruptive or incremental, that begins with the use of digital technologies to evolve toward the holistic digital transformation of the organization (Teichert, 2019). With digital transformation, a new global and intensely interconnected scenario is presented that gives importance to ideas, innovation, and relationships (Kelly, 1999). However, despite the fact that digital transformation in the last two decades has become a global priority (Schwab, 2016; Xu, David, & Kim, 2018) there are still organizations that fail to change their work routines, processes, structure and culture (Almatrodi & Skoumpopoulou, 2023) which has broad implications for strategic management, governance, knowledge management and innovation.

The dynamic and evolutionary nature of digital transformation leads to understanding the process as an integrated framework that allows measurement of the way in which the key capabilities lead to success in the new digital era (Lorenzo, 2016). This maturation process requires progressive changes and incremental improvements aimed at maximizing the value of technology in organizations. In this sense, digital transformation requires the presence of an interdisciplinary and multidimensional model that defines the bases and premises on how the organization interrelates with its ecosystem to generate value (Lorenzo, 2016). However, relatively recent theoretical developments in digital transformation practices appear to be generic, making them suitable for application in various sectors, but none of them offer a specific framework of action for a specific university.

In Chile in 2019 there were 61 universities with a total enrollment of 749,000 students in technical and professional careers, in addition to postgraduate programs (Kerrigan, 2020). Although all of them carry out their own activities to identify and anticipate the digital skills required by the labor market, no studies have been found that reflect the factors that are considered to develop holistic digital transformation processes within universities, much less to measure the evolution of said processes in terms of digital maturity.

This gap in the literature makes it difficult to establish solid foundations to implement a digital transformation project in higher education institutions that allow the different areas of university activity to be addressed in terms of the online teaching modality, the science and innovation system, the digitization of knowledge, and the digitization of university management itself. Although digital transformation in the university context is not a recent issue, there is still no uniform understanding of its implications or how to manage it (Kopp, Gröblinger, & Adams, 2019).

Consequently, considering that the success of any model of disruptive change in the field of higher education requires knowing the cultural and financial particularities of each university, the research was aimed at building a digital transformation model for the specific case of the Autonomous University of Chile based on the factors that are considered essential both by the student population and by experts in this area. Therefore, this article answers the following question: What is the theoretical model of digital transformation that the Autonomous University of Chile can implement?

This is part of a broader investigation, having been fundamentally oriented to elaborate the theoretical design of a digital transformation model for this specific university using a small sample and without trying to validate it using factorial analysis. Nor was it intended to determine the new functions and responsibilities required of the teaching and administrative staff to manage the transformation process, increase the level of digital maturity of the university, promote the creation of new digital spaces for the students, and strengthen the capacity of permanent innovation in products, services, and processes.

To avoid possible confusion, it should be made clear that the digital transformation model describes a change process that uses technology as the basis for its design and implementation. Therefore, in this article, the expressions "digital transformation model" and "digital transformation process" are used in an equivalent way for the purposes of disseminating the results of this research.

2. LITERATURE REVIEW

2.1. Conceptual Elements of Digital Transformation

From a conceptual standpoint, digital transformation has been approached through various lenses. Some view it as a dynamic process, either disruptive or incremental, commencing with the utilization of digital technologies and progressing toward the comprehensive digital transformation of an organization (Teichert, 2019). It has been defined as "a process aiming to enhance an entity by inducing significant changes in its properties through combinations of information, computing, communication, and connectivity technologies" (Vial, 2019). Another conceptualization perceives digital transformation as an organizational process (Brdesee, 2021) fostering the development of new models and competencies strategically supported by digital technologies and insights into student success factors, resource allocation, and the effectiveness of educational and institutional programs (Adam Marks, Al-Ali, & Rietsema, 2016).

An alternate perspective characterizes digital transformation as "the profound and expedited transformation of activities, processes, competencies, and business models to fully leverage the changes and opportunities presented by digital technologies in a strategic and prioritized manner" (Demirkan et al., 2016). Contrarily, some authors conceive digital transformation not as a transformation process but as a management process guiding an organization's culture, strategy, methodologies, and capabilities based on the use of digital technologies (Crespo & Pariente, 2018). Similarly, it has been defined as a strategic process to integrate digital technologies such as data analysis and automation, instigating changes in work routines, processes, structure, and culture (Almatrodi & Skoumpopoulou, 2023).

Regardless of the chosen approach, there is a consensus in the literature that the digital transformation process extends beyond the technological realm, influencing organizational culture and structure. This aligns with the assertion by Hess, Benlian, Matt, and Wiesböck (2016) who emphasized that this process not only impacts the

866

emergence of new business models and the enhancement of customer experience but also entails the redefinition of business objectives, leadership, and hierarchical structures.

The intricacy of factors involved in digital transformation has been emphasized by Rossmann (2019) who highlighted the need to cultivate capabilities related to leadership, market understanding, operations, workforce skills, culture, governance, and technology. Other scholars relate digital transformation to organizational values (culture), management capacity, organizational infrastructure, and workforce capabilities (Muehlburger, Rückel, & Koch, 2019). However, the literature also documents a high failure rate in digital transformation projects (87.5%), primarily attributed to the formulation of unrealistic expectations, governance errors, and limited scope (Wade & Shan, 2020).

Brdesee (2021) posits that digital transformation rests on five foundational pillars: (1) a digital business strategy, (2) the organization's commitment to customers and users, (3) a culture of innovation, (4) technology, and (5) data analysis. This suggests that digital transformation transcends technological boundaries to become a strategic component of the value creation system. It has been argued that the true driving force behind digital transformation is strategy, not technology (Kane, Palmer, Phillips, Kiron, & Buckley, 2015). This viewpoint is supported by Bounfour (2016) who outlines four dimensions of digital transformation: purpose, scope or degree of digitization, speed of implementation of the digital transformation strategy, and sources of value creation in the digital space. Similarly, Hess et al. (2016) argue that the fundamental components of this strategy include the use of technology, changes in value creation, structural changes, and finance.

In light of the above, it can be inferred that any digital transformation process is inherently complex, necessitating organizations to adopt a systematic approach that considers the multifaceted dimensions that extend beyond technology. The absence of a comprehensive approach might impede the timely identification of problems or overlook optimal solutions tailored to each organization's specific circumstances.

2.2. Digital Transformation in Higher Education Institutions

Literature on the maturity of digital transformation in higher education is scarce (Marks, AL-Ali, Atassi, Abualkishik, & Rezgui, 2020). The Covid-19 crisis and the accelerated development of digitization has not only changed the conditions in which education occurs but has also modified the foundations of education itself (Stare, Klun, & Dečman, 2023). For this reason, teachers and students face the challenge of strengthening their digital skills, which are a dynamic combination of skills, knowledge, and ways of thinking about information, communication and digital technologies (Saienko, Kurysh, & Siliutina, 2022).

This dynamism is driven by the significant changes that are taking place in a highly volatile, uncertain, complex, and ambiguous environment (Nowacka & Rzemieniak, 2021) in which not only the adoption of technologies by companies and consumers is accelerating, but also the ability to innovate. Therefore, society is facing a radical change due to the development of digital technologies and their deep incursion into all areas, whether personal, work, or professional. This forces academic institutions to embrace creativity and technology as part of the core skill set required by successful organizations (Christensen, McDonald, Altman, & Palmer, 2018).

The phenomenon of digital transformation has been widely explored in different academic domains, but knowledge on this object of study is still fragmented and ignores the existence of a methodology that allows the digitization of business models, the stages that must be considered, and the factors that enhance this process (Sayabek, Suieubayeva, & Utegenova, 2020). Zaoui and Souissi (2020) pointed out that the main concern in this transformation is defining a vision and a roadmap that determine the path to follow. In the context of higher education, even when universities offer complete, up-to-date and consistent information on their key assets through various digital services and communication channels, they also face the challenge of the diversity of intrinsic data that is duplicated and dispersed, making it difficult to correlate due to the different formats, conventions and

terminology used (Maltese, 2018). These are factors that threaten organizational efficiency, with digital transformation being the most important factor (Brdesee, 2021).

García-Peñalvo (2021) pointed out that the development of digital skills in higher education institutions has been a positive leap; however, if the maturity of digital transformation strategies is analyzed, it can be deduced that full digital transformation is still far from being achieved. This would force the governing bodies of the universities to reflect on the transformation model they require, but always understanding it from a systemic perspective that considers the social, cultural, economic, and environmental dimensions (Cerdá Suárez, Núñez-Valdés, & Quirós y Alpera, 2021).

Considering the fundamental mission of higher education institutions and understanding digital transformation as a response to development globally (Bagdasarian, Stupina, Goryacheva, & Shmeleva, 2020), it is evident that universities, initially seen as organizations, must be transformed internally to be able to play their pivotal role in today's digital world. At the same time, they must be seen as reliable channels of knowledge distribution for society and can be called upon to improve the understanding and application of management concepts and practices that allow a more strategic use of technologies with an approach that responds to the challenges of the digital revolution (Chinkes & Julien, 2019).

For universities to be able to effectively fulfill their social mission in today's digital world, a better understanding of the needs of the labor market, society and their students, teachers and researchers is required. In addition, they must generate a culture of collaboration with greater flexibility, more agility and better adaptability. According to Chinkes and Julien (2019) digital transformation "must be approached without delay, but also with a critical and reflective approach under the particularities of each institution." Investment in the implementation of digital technology must take place "in an integrated way with all the dimensions of the organization: strategy, people and culture, structure and management systems, business processes, and, of course, technology" (Lorenzo, 2016).

An insightful addition to the literature comes from Awdziej, Jaciow, Lipowski, Tkaczyk, and Wolny (2023), who posit that the success of digital transformation in universities necessitates a culture of digital maturity among all stakeholders in addition to having technical and support infrastructure. This implies that university staff must possess the requisite skills and knowledge to design and deliver digital learning experiences to students. Simultaneously, students should have the capacity to effectively utilize digital tools to enhance learning and personal development, demonstrating ethical and responsible use of technology, fostering critical thinking, and embodying digital citizenship principles.

The need to develop digital transformation strategies in universities is consistent with the need to remain competitive in global education, which means considering the long-term implications of the interactions among politics, economics, science, technology, and society (Mohamed, Tlemsani, & Matthews, 2022).

2.3. Digital Transformation Models

In the research literature on digital transformation, "models do not play a prominent role" (Gray & Rumpe, 2017). The conceptual models of digital transformation are of vital importance so that universities can be sustainable in a context characterized by rapid technological changes; however, in the literature there are few models of digital transformation that combine technologies, systems and educational phenomena aimed at students obtaining both cognitive and emotional learning (Mohamed Hashim, Tlemsani, & Duncan Matthews, 2022). Consequently, the digital transformation in higher education, with a focus on sustainability, implies the need to consider that transformation strategies, sustainable practices and technology-based education are relatively different areas but are intrinsically interrelated. Therefore, the success of any effort in this sense would force us to consider it as a dynamic phenomenon that is influenced by global changes and new technological developments, requiring careful management and control at the same time (Mohamed Hashim et al., 2022).

Perhaps for this reason, and as indicated above, no digital transformation models have been found that are specific to the case of universities; therefore, it is necessary to adapt models created for other business and service sectors, such as that of Westerman, Bonnet, and McAfee (2012) who demonstrated the existence of a clear correlation between digitization and competitiveness and designed a model that offers an integrated structure that allows any type of organization to evolve gradually and progressively regarding the development of key capabilities to be successful in the new digital age.

In this study, in which 400 North American companies participated, they conceived the concept of 'digital maturity' that describes the way in which different companies react to digital opportunities and designed a pioneering model called the Digital Maturity Indicator (DMI) that has four levels of maturity that depend on the combination of two closely related aspects: (1) digital intensity, or the level of investment in technology initiatives aimed at changing the way the company operates; and (2) the intensity of transformation management, which is the level of investment in leadership capabilities required to create digital transformation within an organization, shaping a new future based on governance and commitment to implement technology-based change (see Table 1).

Table 1. Digital maturity indicator model.

Digital identity	**High digital intensity and low transformation management intensity** Fashionistas, or followers of digital fashion, who are strongly motivated to bring about digital change, but with a strategy that is not based on relevant knowledge of how this transformation can and should add value to the business.	**High digital intensity and transformation management** Digital experts who know how to add value to the business through digital transformation. They combine vision and governance with a commitment to investment. Thanks to the global vision and the integration of the entire organization in the digital transformation strategy, they successfully develop a digital culture that allows them to incorporate recent changes into their business model.
	Low digital and transformation management intensity Beginners or digital beginners who have experienced and implemented technological solutions. They lack a coordinated strategy and a comprehensive vision of the transformation.	**Low digital intensity and high transformation management intensity** Conservatives, or digital conservatives, who understand the importance of strategy, coordination, governance issues and organizational culture when addressing a transformation process, but who are skeptical of the value of digital in these processes. However, they are willing to invest in digital change, but their slowness leads to them losing opportunities to other organizations.
	Intensity of transformation management	

Note: Information extracted from Westerman et al. (2012).

One model that stands out for its simplicity is the McKinsey model, presented by Catlin et al. (2015), who conducted a study of 150 companies globally to understand the challenges of digitization in organizations. This model, which the author called "Digital Quotient", incorporates a set of dimensions and factors that measure the digital maturity of a company, as shown in Table 2.

This model begins with the establishment of a clear and precise digital strategy, an integral part of the company's overall strategy, that emphasizes the critical role of alignment for successful digital transformation. Three key points are proposed to design an effective digital strategy: identify the most relevant opportunities and threats, assess the potential speed and scale of digital disruption in the sector, and determine the optimal proactive opportunities and resource reallocation strategies in response to significant threats. A second crucial aspect involves organizational culture, which is considered paramount in the digital transformation process. Culture is viewed as instrumental in fostering skills related to speed, flexibility, open innovation, and learning based on the lean start-up model (Lorenzo, 2016; Ries, 2011). Lorenzo (2016) defines digital culture as the collection of behaviors and habits cultivated and applied by managers and employees to leverage the potential of new technologies. It is argued that the presence of digital technologies signifies the existence of a digital culture, encapsulating the artifacts and communication systems that define contemporary ways of life (Uzelac, 2008).

Table 2. Dimensions and factors of the McKinsey digital quotient model.

Dimension	Factors
Strategy	Bold, long-term orientation
	Linked to business strategy
	Focused on customer needs
Culture	Risk appetite
	Speed/agility
	Test and learn
	Internal collaboration
	External orientation
Organization	Roles and responsibilities
	Talent and learning
	Governance
	Digital investment
Capabilities	Connectivity
	Contents
	Customer experience
	Decision-making based on data
	Automation
	IT architecture

Source: McKinsey composite.
Catlin et al. (2015)

A third dimension of the model points to the development of a set of practices related to processes, structure and talent, mainly at the middle management level, since they are the ones who execute digital initiatives and are responsible for the development of new products, services, and organizational models (Lorenzo, 2016).

The last aspect included in the McKinsey Digital Quotient is associated with capabilities around three key functions: (1) translating business needs into digital language; (2) developing insights to leverage new data sources and quality algorithms; and (3) verifying that future data requirements are adequate and complete (Catlin et al., 2015). The capabilities listed in Table 3 are characterized as critical.

Table 3. Critical capabilities that must be developed according to the digital quotient model.

Capability	Description
Data-driven decision making	Changes in decision-making processes, from models where a manager bases his decisions on experience to decision models based on evidence and data
Connectivity	Using technology to unleash deeper relationships and connections between brands and customers.
Process automation	Automation efforts in key business processes
Two-speed information technology	Operation of two technological capacities; the first is associated with the platforms designed to deliver rapid results to customers and the identified opportunities, and the second is associated with the technologies already implemented to optimize the organization's traditional and back office operations

Source: Lorenzo (2016)

Subsequently, to help telecommunications service providers understand their digital maturity at a given moment and support them in the development of a vision and path for digital transformation, Valdez-de-Leon (2016) designed a digital maturity model with a focus on the function of universities as organizations that provide educational services. The author states that, although the model has been designed for the telecommunications sector, the conceptual framework could be used in other service organizations. The model presents the seven dimensions indicated in Table 4:

Table 4. Initial structure of the maturity model for telecommunications service providers.

Dimensions	Description
Strategy	Vision, governance, planning, and management of processes that will support the execution of the digital strategy
Organization	Changes in culture, structure, training, and knowledge management that will enable the organization to become a digital player
Customer	New benefits created in the customer experience through digital changes in their journeys
Ecosystem	Development and support of partner ecosystems as a key element for a digital business
Operations	Capacities that support the provision of services; increased maturity because of more digitized, automated, and flexible operations
Technology	Effective technology planning, deployment, integration, and use of technology to support digital business
Innovation	New flexible and agile ways of working that will form the basis for an effective digital business

Source: Valdez-de-Leon (2016).

In this model, Valdez-de-Leon (2016) considers that the speed of digital transformation does not occur equally in all dimensions, which is why he conceives a progressive approach with a six-level maturity scale with the following meanings:

- Level 0: Not started: The organization has not taken any steps to transform itself.
- Level 1: Initiating: The organization has decided to move toward a digital business and is taking the first steps in that direction.
- Level 2: Enabling: the organization is implementing initiatives within the dimension that will form the basis of its digital business.
- Level 3: Integration: the initiatives of the organization are integrated throughout the organization to support the capabilities from one end to another.
- Level 4: Optimization: The organization's digital initiatives within the dimension are being adjusted and used to further increase overall performance.
- Level 5: Pioneering: The organization is breaking new ground and advancing the state of the practice within the dimension.

This means that, at a given moment, each dimension of the model will be at a certain level of digital maturity, serving as a diagnostic tool for the vision, context, and challenges that the organization will face during its transformation process.

In the specific context of higher education institutions, although universities have been pioneers in the use of digital technologies and have been establishing digital educational solutions for some time, they have not yet achieved digital transformation. According to Bygstad, Øvrelid, Ludvigsen, and Dæhlen (2022) the digitization of core university tasks has followed separate and non-integrated paths, in addition to the fact that educational solutions were fragmented and generally supported by the simple implementation of digital tools, stimulating some incremental improvements but without achieving disruptive changes.

The different approaches and the diversity of the dimensions used in the literature on digital transformation in the university context and its impact on maturity reveal a fragmented image that, according to Teichert (2019) reveals the impact of culture on transformational capabilities, which in turn would explain the existence of multiple visions of maturity of digital transformation seen as a holistic concept. From the foregoing, it can be inferred that any digital transformation model must respond to the characteristics of the context in which it will be applied since cultural, economic and structural factors are involved that are particular to each one.

One of the models oriented toward digital transformation in universities is that of Castro et al. (2022) in which five levels of maturity are established (see Table 5).

Table 5. Maturity levels of the digital transformation process.

Maturity level	Description
Unrated	The university lacks defined objectives and a digital transformation strategy. The success of some digital initiatives usually depends on individual effort, and the benefits obtained do not extend to other departments, programs and/or faculties. It lacks information on digitalization processes, or it is an incipient process. Staff (Students, teachers, administrators) have little to no digital skills. The technology available to the university does not allow the digitization of the business.
Under	The university has identified the need to increase discrete digital initiatives to solve isolated business problems and allocates financial resources for their execution. However, the worldview remains unchanged. Some internal initiatives of digital products and services that have been successful in the past are beginning to be replicated in other departments, programs and/or faculties. The staff (Students, teachers, administrators) have basic digital skills. There is strong resistance to change. The university has the technological equipment to execute digital initiatives; however, the budgetary availability required to acquire them is restricted.
Moderate	The university analyzes its worldview and sees the need to make changes in the medium-term university objectives. It incorporates digitization initiatives and digital user experiences, although it does not yet focus on the disruptive potential of transformation. Therefore, the investment and use of new technologies is done with caution. The staff (Students, teachers, administrators) have moderate digital skills and resistance to change is still evident.
High	The university has understood, accepted, and internalized the new digital paradigm, and has decided to transform itself. Therefore, the digital transformation capacities of the university are perfectly adapted and incorporated into the vision, strategy, objectives, and processes of the university, and it also has strategic planning that enables a successful transition to the new digital transformation paradigm. The university's business model has been modernized, is focused on the user, and is adapted to the digital age. The university begins to obtain competitive advantages over other universities. The staff (Students, teachers, administrators) have the required digital skills, resistance to change does not persist, digital culture has been internalized. The university has the necessary technology to achieve digital transformation.
Very high	The university is very innovative in its use of technology and new business models. It flows naturally in the new digital paradigm and continuously evaluates new technologies and their possible application. The processes are automated, and advanced data analysis is used for decision making. It is a visionary and intelligent university. The staff (Students, teachers, administrators) is immersed in a new digital culture.

Source: Castro et al. (2022)

This study approaches the process of digital transformation of universities from three main perspectives: organizational, sociocultural and technological. Based on the postulates of Chanias (Castro et al., 2022), five aspects have been identified that are implicit in this process: (1) strategic transformation management, (2) supply of digital products and services, (3) digitization of processes and internal operations, (4) digital interaction with clients, and (5) the use and development of information technology. Once some models of digital maturity have been characterized, Table 6 presents a summary of these contributions in terms of their main dimensions, which constitute the structural basis for the construction of a digital transformation model for universities.

Table 6. Contributions of the literature considered for the construction of the digital transformation model for universities (Model dimensions).

Digital maturity indicator model (Westerman et al., 2012)	McKinsey digital quotient model (Catlin et al., 2015)	Maturity model for telecommunications service providers (Valdez-de-Leon, 2016)
• Investment in leadership skills • Digital initiatives • Management in digital transformation • Digital culture	• Strategy • Culture • Organization • Capabilities	• Customer • Ecosystem • Operations • Technology

A brief review of the theoretical contributions that support the design of the digital transformation model for universities allows us to confirm the presence of the five aspects in said process, as mentioned by Castro et al. (2022).

Based on the literature, Table 7 shows the dimensions that will make up the preliminary structure of the digital transformation model for universities.

Table 7. Preliminary structure of the digital transformation model for universities.

Theoretical support	Dimension	Description
Catlin et al. (2015)	Key capabilities and resources	This involves digitizing the aspects that generate value within the organization and that are sources of competitive advantages such as connectivity, customer experience, decision-making based on data, automation, architecture.
	IT investment	Adequate technical support. Digitization of physical machines. Virtualization. From analog to digital.
Crespo and Pariente (2018)	Institutional strategic framework focused on digital transformation	A comprehensive strategy focused on the service delivered by the university and driven by digital, which involves all the processes that generate value in the long, medium, and short terms. It involves adapting the corporate, business, and functional strategy to a digital modality.
Valdez-de-Leon (2016)	Student life cycle	New benefits created in the student experience thanks to digital transformation. It involves the students' passage through the university, promotion, recruitment campaigns, registration, teaching, job search and follow-up of alumni.
	Ecosystem	Focused on the experience of stakeholders, it refers to the development of a strategic network of allies as a key element for a comprehensive solution for the students.
	Processes	Transforming teaching for digital education. Transforming the teaching and learning dynamics.
Gobble (2018)	Organization and Structure	Organizing functions within the university. Roles and responsibilities, talent and learning, form of governance, IT leadership, way of designing work and adapting it through information and communication technology (ICT).
Furedi (2011)	Points of contact with the students	Students need to be assisted at any time, from anywhere and on any device. Service points must be digitized.
Salinas and Vio (2011)	Flexible and personalized teaching	From a one-size-fits-all teaching to tailored teaching. Managing individualized student information through predictive data analysis to offer individualized counseling systems.
Sánchez and Fernández (2010)	Social networks and profile research	This involves educational marketing and recruitment of new students. Click-through rate is analyzed, which is a digital marketing measure to evaluate the performance of content on the internet, whether on Google or social media. Understand the perception among the public regarding the academic programs of the university, identify points to improve in the service and create new programs to respond to needs.
Westerman et al. (2012)	Digital culture	Dimension resulting from combining: (1) digital intensity or the level of investment in technological initiatives, and (2) the intensity of digital transformation management, understood as the level of investment in leadership capabilities to implement technology-based changes.

As explained in Table 7, the structural basis for the creation of a digital transformation model for universities is based on the models of Valdez-de-Leon (2016) and McKinsey (Catlin et al., 2015) and the contributions of Crespo and Pariente (2018); Gobble (2018); Furedi (2011); Salinas and Vio (2011) and Sánchez and Fernández (2010).

The construction of the model starts from the premise that it is possible to reach a certain maturity of the strategic processes of a university if the level of digitization of each dimension proposed in the construct reaches its highest level (see Table 8); that is, if most of the factors of each dimension are met (Oldfield & Baron, 2000).

Table 8. Implicit factors in each of the dimensions considered for the digital transformation model.

Dimension	Factors
1. Institutional strategic framework focused on digital transformation	• Mission and vision statements that focus on digital • Strategic objectives with a focus on IT • Positioning through digital platforms • Student loyalty strategies with a digital approach • Digital initiatives aligned with corporate strategy
2. Digital culture	• Training that is focused on digital technologies • Promotion of projects on digital issues • Tolerance to changes • Continuous learning ability • Comprehensive approach to the student experience
3. Organization and structure	• Digital technologies used in organizational processes • Digitized administrative processes • Digital technologies in workflows • Organizational structure adaptable to digital • Decision making that incorporates IT
4. Critical capabilities and key resources	• Decision making guided by data • IT focus on student loyalty and university branding • Problem solving for students with an IT approach • Technologies for the optimization of the organization's back office • Accessible services anywhere and at any time
5. Student life cycle value	• Digitization of the student life cycle • Incorporation of IT for student satisfaction and retention • Academic and pedagogical support with a focus on IT • Labor internships and job search with a digital focus • Incorporation of IT for the continuity of studies
6. Ecosystem (partners and strategic allies that a university should have)	• Relations with companies and corporations • Relations with communities and social groups • Relations with foundations/NGOs • Relations with international universities • Links with the educational community and professors from other universities
7. Flexible and personalized teaching	• Incorporation of IT in the rhythm of student study • A teaching model appropriate to the physical location of the student • Use of predictive data to anticipate student needs • Individualized counseling system • Adequacy of teaching to the profile of each student
8. Points of contact with the students	• Digitized library • Digital platform for student affairs • IT support to foster work groups • Casino services with digital support • Digital support for the student–director–secretary relationship
9. Social networks and profile research	• Analysis of positioning indicators • Analysis of students' perceptions of social networks • Identification of points of improvement in digital services

Dimension	Factors
	• Recruitment of potential students through social networks • Promotion of collaborative learning through social networks
10. Processes of transformation of teaching for higher education	• Application of ICT in the teaching and learning processes • Training in digital pedagogical strategies • Integration of a student life project – teaching strategy • Incorporation of digital teaching strategies in pursuit of family integration • Integration of the socioeconomic level of the student into digital teaching strategies
11. IT investment	• Investment in learning platforms • Quality technical support in digital processes • Automation of teaching services aimed at students • Investment in administrative technology platforms • Improvement of contact points with students through ICT

In summary, from the review of the theoretical aspects that feed the design of the digital transformation model for the Autonomous University of Chile, the need to address this process from a systemic perspective that contributes to satisfying the needs of all agents is highlighted. It should be relevant to the university context and consider the organizational, socio-cultural, and technological aspects in harmony with the requirements of the educational community and in a manner consistent with the needs and expectations of society.

3. METHODOLOGY

3.1. Research Design

As indicated in the literature review, any digital transformation effort must be oriented to ensure a satisfactory user experience (Hess et al., 2016). Consequently, in the field of higher education, the focus of attention is the student, so the design of a model that successfully faces the challenges that arise from a process of digital transformation at the Autonomous University of Chile will depend fundamentally on the perceptions of the students regarding each of the implicit factors in the process. However, students are not the only interested party. People who hold positions of responsibility in the academic, technical, and administrative areas also have points of view that contribute to mapping the critical aspects that must be considered in the design of a digital transformation model consistent with the idiosyncrasies and cultural values of the university. Consequently, due to the fact that the nature of the data necessary to develop the model had to be collected directly from the parties involved, a field design with a mixed (quantitative and qualitative), cross-sectional and exploratory approach was used (Malhotra, 2004).

3.2. Sample Selection

Due to the different natures of the data to be collected, and given the exploratory level of the research, non-probabilistic techniques (convenience sampling) were used (see Table 9) based on the approaches of Denzin and Lincoln (2000).

Table 9. Sample composition.

Sample description	Sample size	Gender distribution	Distribution by study area	Technique (Instrument)
Undergraduate students at the Autonomous University of Chile	97	55 Men (56.7%) 42 Women (43.3%)	Administration and economics (73.2%) Engineering (24.7%) Other areas of study (2.1%)	Survey (Questionnaire)
Experts	8	6 Men (75%) 2 Women (25%)	-	In-depth interviews

875

The selection of students who participated in the study was carried out according to the opportunity that was presented to collect the data, always emphasizing the voluntary nature of participation. Consequently, no random methods were used to select the informants and the sample was not intended to be statistically representative of the student population.

On the other hand, the selection of the experts was made based on their suitability, availability, and motivation to participate. Suitability was conditioned by two criteria: (a) cognitive domain regarding the concept and implications of digital transformation processes in the educational field, and (b) direct involvement in decision making at the Autonomous University of Chile. The personal data of the experts consulted were kept anonymous throughout the research process.

3.3. Data Collection Instruments

A preliminary model composed of 11 dimensions and 55 underlying factors was created to collect student data based on the contributions of the literature. Subsequently, its relevance and practical applicability were evaluated through a questionnaire that was previously subjected to validation using the expert judgment technique with the participation of 40 evaluators. Each expert was provided with a questionnaire detailing the dimensions and preliminary factors linked to the construct together with the assessment criteria to indicate the degree of importance of each item of the instrument. To do this, the respondents had three options: 'essential', 'useful but not essential' or 'not essential'. With the data, and following Lawshe's model (Lawshe, 1975), the content validity ratio (CVR and CVR´) was determined for each of the items, and the global content validity (CVI) was calculated for the entire instrument.

Table 10. Formulas used to determine the content validity of the instrument.

Calculation of the content validity ratio for each item	Calculation of the content validity ratio for each item (Adjusted Lawshe's model)	Calculation of the global validity of the instrument
$$CVR = \dfrac{n_e - \frac{N}{2}}{\frac{N}{2}}$$	$$CVR' = \dfrac{CVR + 1}{2}$$	$$CVI = \dfrac{\sum_{i=1}^{M} CVRi}{M}$$
ne = Total number of experts who consider the item as "essential" N = Total number of experts who answered the instrument	CVR = Content validity ratio for each item	CVRi = Content validity ratio of the accepted items M = Total items accepted in the instrument

As a result of this process, the nine proposed dimensions were validated by obtaining a global validity of 0.661. Regarding the implicit factors in the dimensions, only one could not be validated by obtaining an adjusted validity ratio of 0.375. The overall content validity of the instrument was 0.714. Table 10 shows the formulas used to determine the content validity ratio for each item (CVR); adjusted content validity ratio (CVR'), and content validity index (CVI).

Once the questionnaire was validated, it was sent via Google Forms to the 97 students who participated in the study. This questionnaire was structured in three sections:

- The first section collected the general data of the respondents (gender, academic level, and disciplinary area to which they belong).
- The second section contained the eleven dimensions of the preliminary theoretical model, with their respective definitions, so that the participants could indicate the degree of importance they attributed to each dimension using a Likert scale with five response options. The response options were: 1 = Not important, 2 = Unimportant, 3 = Neutral, 4 = Important, and 5 = Very important.

- The third section contained a set of 54 factors related to each of the dimensions listed in the previous section. The participants were asked to attribute a degree of importance of each factor to manage the digital transformation of a university. To do this, they used the Likert scale with five response options: 1 = Strongly disagree, 2 = Disagree, 3 = Neither agree nor disagree, 4 = Agree, and 5 = Strongly agree.

In relation to the qualitative techniques for collecting information, eight semi-structured interviews were conducted with managers from the Autonomous University of Chile and experts in digital transformation, who contributed their knowledge, reflections, and assessments on the object of study. For this, an interview protocol was previously prepared (see Appendix I) comprising 10 questions to be answered openly by the interviewees. This protocol was only used as a guide for the researchers and allowed for the possibility of asking other questions related to the accounts of the interviewees. All were carried out face to face where the informants carried out their daily work activities. The average duration of each interview was 1.4 hours.

3.4. Data Analysis Procedures

The data obtained through the questionnaires was processed using measures of central tendency. Firstly, the relative weight of each dimension was determined by obtaining the relative weight that corresponded to each of the factors. These results correspond to the data recorded in the second section of the questionnaire. The same procedure was applied to each of the indicators in the third section. After obtaining the average valuation for each indicator, this value was multiplied by the relative weight of the corresponding factor to obtain the weighted weight of each indicator in the total set of the transformation model. This made it possible to determine the students' assessment of each indicator.

Regarding the qualitative data, the interviews were recorded, transcribed, and subjected to a coding process in which conceptual categories were assigned to the information segments that were of interest to achieve the objectives of the study. The analysis was carried out in three phases: Firstly, a microanalysis of each interview was carried out, beginning an open coding process with Atlas.ti software, which facilitated the preparation of analytical memos in which the most important aspects were highlighted. In this phase, a global idea of the data was obtained, and it ended with a broad description of each of the categories analyzed. In the second phase, the data obtained in the previous phase was grouped and classified using descriptive codes that gave meaning to each of the questions asked to the interviewees. Through axial coding, these descriptive units were grouped into categories, and new memos were produced describing the properties of each one. Finally, in the third phase, through the elaboration of an intensity matrix, significant relationships and guidelines were created that allowed the theoretical model of the digital transformation process of a university to be elaborated. In this sense, this model consolidates and integrates the information provided by both the students who answered the questionnaire and the experts interviewed.

4. RESULTS

This section details the results obtained during data collection that allowed the structuring of the theoretical model for the digital transformation process for a university. The section is divided into three sections: (1) quantitative results, (2) qualitative results, and (3) description of the model.

4.1. Quantitative Results

The quantitative results shown below derive from the analysis of the data collected through the questionnaire administered to 97 undergraduate students (55 men and 42 women) of the Administration and Economics curricular programs (73.2%), Engineering (24.7%), and other subjects (2.0%) at the Autonomous University of Chile, obtaining a Cronbach's alpha reliability coefficient of 0.9478.

The quantitative analysis of the results showed an equitable distribution of the importance attributed to each of the dimensions implicit in the digital transformation of a university (see Figure 1), with the understanding that said

877

transformation is the management process that guides the culture, strategy, methodologies, and capacities of an organization from the use of digital technologies (Crespo & Pariente, 2018).
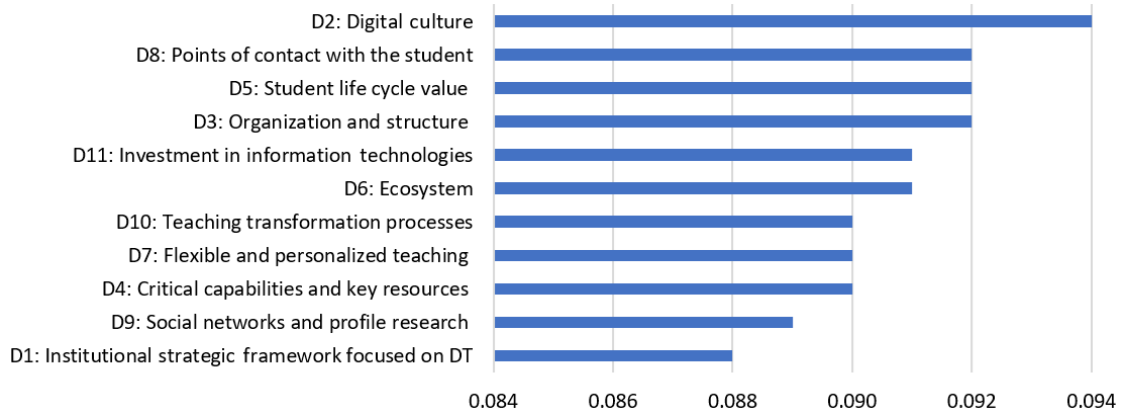

Figure 1. Implicit dimensions in the digital transformation (DT) process of a university and the importance attributed to each.

Table 11. Implicit factors in the digital transformation process of a university (By dimension and weighted weight).

Dimension/Factor	Average rating	Relative weight	Weighted weight
D1: Institutional strategic framework focused on digital transformation [0.088]			
Digital initiatives aligned with corporate strategy	4.577	0.404	1.838
Positioning through digital platforms	4.495	0.397	1.805
IT-focused strategic objectives	4.485	0.396	1.801
Student loyalty strategies with a digital focus	4.443	0.392	1.785
Mission and vision statements that focus on digital	4.423	0.391	1.776
D2: Digital culture [0.094]			
Continuous learning ability	4.588	0.430	1.957
Change tolerance	4.567	0.429	1.948
Comprehensive approach to the student experience	4.557	0.428	1.944
Training focused on digital technologies	4.505	0.423	1.922
Promotion of projects on digital issues	4.433	0.416	1.891
D3: Organization and structure [0.092]			
Organizational structure adaptable to digital	4.567	0.420	1.909
Digitized administrative processes	4.505	0.414	1.883
Digital technologies present in organizational processes	4.474	0.411	1.870
Decision making incorporating IT	4.469	0.411	1.868
Digital technologies in workflows	4.454	0.409	1.862
D4: Critical capabilities and key resources [0.090]			
Accessible services anywhere and at any time	4.629	0.426	1.939
Solving problems for students, with an IT-based approach	4.495	0.405	1.840
Technologies in the back-office optimization of the organization	4.464	0.402	1.827
Data-driven decision making	4.443	0.399	1.815
IT focus on student loyalty and university brand	4.402	0.396	1.802
D5: Student life cycle value [0.092]			
Academic and pedagogical support with a focus on IT	4.505	0.415	1.887
Incorporation of IT for continuity of studies	4.495	0.414	1.862
Labor practices and job searches with a digital approach	4.454	0.410	1.866
IT incorporation for student satisfaction and retention	4.443	0.409	1.862
Digitization of the student life cycle	4.402	0.406	1.844
D6: Ecosystem (partners and strategic allies that a university should have) [0.091]			
Relations with international universities	4.577	0.416	1.891
Relations with companies and corporations	4.546	0.413	1.878
Links with the educational community and professors from other universities	4.485	0.408	1.853
Relations with communities and social groups	4.412	0.401	1.823
Networks with foundations/NGOs	4.320	0.393	1.785
D7: Flexible and personalized teaching [0.090]			

Dimension/Factor	Average rating	Relative weight	Weighted weight
Individualized counseling system	4.433	0.401	1.935
Teaching model appropriate to the physical location of the student	4.423	0.400	1.819
Using predictive data to anticipate student needs	4.412	0.399	1.815
Incorporation of IT into the students' study rhythm	4.402	0.398	1.810
Adequacy of teaching to the profile of each student	4.381	0.396	1.802
D8: Points of contact with the students [0.092]			
Digital platform for student affairs	4.619	0.426	1.935
IT support to foster work groups	4.588	0.423	1.922
Digital support for the student–director–secretary relationship	4.588	0.423	1.922
Digitized library	4.526	0.417	1.896
D9: Social networks and profile research [0.089]			
Identification of points of improvement in digital services	4.433	0.396	1.802
Analysis of positioning indicators	4.371	0.391	1.777
Analysis of students' perceptions of social networks	4.351	0.389	1.768
Promotion of collaborative learning through social networks	4.351	0.389	1.768
Recruitment of potential students through social networks	4.330	0.387	1.760
D10: Teaching transformation processes for higher education [0.090]			
Application of ICT in the teaching and learning processes	4.515	0.405	1.840
Training in digital pedagogical strategies	4.515	0.405	1.840
Integration of the students' socioeconomic level with digital teaching strategies	4.505	0.404	1.835
Integration of a student life project – teaching strategy	4.485	0.402	1.827
Incorporation of digital teaching strategies in pursuit of family integration	4.443	0.398	1.810
D11: Investment in information technology [0.091]			
Investment in learning platforms	4.577	0.418	1.900
Quality technical support for digital processes	4.557	0.416	1.892
Improvement of contact points with students through ICT	4.505	0.411	1.870
Investment in administrative technology platforms	4.485	0.409	1.862
Automation of teaching services aimed at the students	4.454	0.407	1.849

Note: 1. Data obtained from the questionnaire administered to students.
2. The average assessment (Mean value) refers to the average score obtained for each factor using the 5-point Likert scale.
3. The relative weight is the result of multiplying the average score obtained for each factor by the relative weight of the dimension to which it belongs (Shown in brackets).
4. The weighted weight is the result of dividing the relative weight of each factor by the sum of all the relative weights. It indicates the percentage contribution of each factor in the digital transformation process of a university.

In view of the results shown in Table 11, and even though the difference between the dimensions is barely 0.005, it is striking that Institutional Strategic Framework has been considered the least relevant in the process of digital transformation in a university context, understanding that such appreciation is the product of the approach that is typical of the academic profile of the population surveyed.

From the data in Table 11, three main factors in the digital transformation process of a university and, therefore, in determining its degree of digital maturity were identified for "Digital culture". In order of importance, these are:

- Continuous learning ability (1.96%)
- Tolerance to changes (1.95%)
- Comprehensive approach to the student experience (1.94%)

Conversely, the three factors that the respondents considered less relevant during the digital transformation of a university belong to "Social networks and profile research." In descending order, these are indicated below:

- Analysis of students' perceptions of social networks (1.77%)
- Promotion of collaborative learning through social networks (1.77%)
- Recruitment of potential students through social networks (1.76%)

In view of the results, each of the factors contributes to the digital transformation process with an average of 1.852% and a standard deviation of just 0.052%. This reveals the absence of significant differences between factors; therefore, all of them will be considered for the design of the theoretical model of digital transformation.

4.2. Qualitative Results

The results after processing the information gathered through the interviews with the eight experts are shown below. The codes in brackets are the codes assigned to each of the interviewees.

Firstly, there is a clear tendency to focus on the student as one of the fundamental elements in the digital transformation process [M1, M2, M3, M5, M6, M7, M8]; in fact, it was insistently stated that the priority areas for digitalization are associated with students receiving complete, truthful, timely and real information in relation to the academic and administrative processes that concern them [M1, M3, M4], including the digitization of libraries [M7] and the efficient use of learning platforms [M7].

The importance of this aspect is highlighted when it was pointed out that the degree of digital maturity that a university has reached is rooted in student satisfaction [M2, M6, M7], noting that this degree of maturity is always relative since it will depend on user perception [M2]. It is understood that digital maturity incorporates a subjective component that transcends processes, financial aspects and technological capabilities, inferring that the focus on the student experience is vital in the digital transformation processes of universities, and that this approach reflects the institutional culture, its strategic vision, and its capacity to manage that transition.

The previous appreciations are ratified by arguing that the digitization of academic activities is only justified when it affects student satisfaction by improving the online class system, offering attractive digital content, and facilitating the teaching and learning processes [M1, M6], while the digitization of internal processes is justified when it facilitates the exchange of timely and reliable information [M3].

It was also pointed out that another determining factor of a university's digital maturity is computer governance [M6], which facilitates the generation of initiatives and the implementation of digitalization options, affirming that mature universities will be those that have internalized and systematized both the transformation processes and the decision-making processes in this area.

In addition to governance, other indicators of a university's digital maturity are the correlation between academic performance and job positioning [M4], and the possibility for students to conduct their academic activities from home [M8]. This last statement could be revealing a restricted vision of digital transformation, limiting it to the use of online platforms for the purposes of the teaching–learning process; therefore, for the purposes of the investigation, and since a holistic perspective of the process is not evidenced, this statement will only be used for referential purposes.

Apart from the effects derived from the pandemic in terms of the accelerated implementation of digitization processes in fundamental academic areas [M1, M3], and having warned that digitization should not be used as the solution to problems [M2], the interviewees consider the main drivers of digital transformation in universities to be: (1) corporate purposes (vision, mission, strategic objectives) encompassed in culture and organizational strategy [M5], including the desire to stay ahead of the vanguard of knowledge and technology [M7]; (2) commitment to change processes, which is achieved through the training of all members of the educational community [M1]; (3) the learning curve that is acquired through the gradual development of the transformation process [M6]; and (4) effective communication that allows managing the technological base and decision making [M2], understanding that communicative interactions promote technological integration and innovation, even more so when it comes to matrix organizations [M2].

In this sense, assuming that the meaning of digitization is to achieve something that can only be made possible through it, it has been argued that carrying out a digital transformation process implies transforming people's

talents so that they are clear about the strategic approach in terms of what is to be kept and what is to be changed [M5].

From another perspective, it was pointed out that digital maturity implies going through three phases: (1) availability of digital resources, (2) how to use those resources, and (3) integration of technological platforms [M7]. From this assessment, it can be inferred that the digital maturity indicators should be associated with the factors that measure the degree of progress in the transformation process based on the objectives to be achieved (see Figure 2).

It was also indicated that one of the drivers of digital transformation is the need to level the requirements regarding the admission of students to public and private universities. This statement was only pointed out by one interviewee [M4] and is not considered significant in the design of the digital transformation model.

Figure 2. Phases of the digital transformation process in a university.
Note: Based on the qualitative analysis of the interviews conducted with experts.

However, as it has been mostly indicated that the conditions are in place to initiate digital transformation processes in Chilean universities, certain difficulties associated with aspects of cultural and financial natures were also recognized due to the need to make the corresponding investments in technology. According to the interviewees, these elements (culture and investment in new technologies) can make a difference in terms of the level of digital maturity that the university has reached, to which the type of technology that is being used should be added [M1, M5], the skills to manage that technology [M1, M4, M5], the capacities for decision making [M1], the leadership that is exercised [M5], and the skills to manage change [M4, M5, M6]. In this sense, criticism has been drawn about the way in which new technologies are being used, pointing out that their full potential has not yet been recognized [M5].

Regarding cultural aspects, the influence of the generational component [M2, M7] has been highlighted in the possibility of initiating and managing processes of innovation and integration of digital technologies, arguing the need to incorporate young academics (age component) with a vision of the digital context [M2] and with high learning capacity [M7]. This could be why one of the main obstacles to digital transformation in the university context lies in the resistance to change [M5, M7], its inadequate management [M2], and the lack of conviction regarding the need for digitization [M3], which is closely linked to the culture of the organization.

It was also pointed out that the difficulty in combining hard technical skills with soft skills could create difficulties in conducting digital transformation processes, especially in the early phases, which justifies the need for constant monitoring to anticipate possible risks that could lead to a failure of the digitization project [M4]. This becomes more relevant if the differences derived from the structural aspects that characterize the Chilean university system are considered. In fact, although there is a general conviction among those interviewed that both public and

private universities need to initiate profound digital transformation processes, significant differences between them have been pointed out, highlighting the following:

- Private universities are more student-centered than public universities [M1]
- Private universities show greater interest in addressing digital transformation processes [M3]
- Private universities incorporate changes faster than public universities [M2]
- Public universities have a deeply rooted bureaucratic system and greater regulatory rigidity than private universities, which can translate into slower decision making [M2, M6, M7].
- Public universities have more resources than private universities to start digital transformation processes [M7]

Regardless of the type of university, be it public or private, there is a broad consensus that the leadership of transformation processes should be assumed by the higher levels of the organization, who should also be charge of planning, innovation and development [M2, M3] from which it can expand to the various functional areas to structure a team responsible for the overall transformation [M5]. The importance of understanding the digital transformation process as an institutional policy emanating from the board of directors or the university government [M3] from which people are mobilized to address the changes that are required [M6] has been stressed to promote innovation [M7] and integrate digital technologies in the various areas of the university [M7]. Having recognized the existing gap between human capacities and the way of managing changes [M6], the danger of trying to digitize the entire organization abruptly has been pointed out, with the advisability of carrying out pilot transformation projects aimed at obtaining small changes that serve to leverage other larger ones [M6]. In this way, the importance of permanent learning has been highlighted [M6, M7] as one of the factors capable of promoting the digital transformation process, together with the leadership that must be assumed, both by the area responsible for managing information technology [M4] and by the academic area [M8].

The above allows us to highlight three issues that seem to be fundamental in the digital transformation processes: (1) the set of cultural aspects that characterize the university from which the strategic decisions on technological base and financial resources necessary for the digital transformation emerge; (2) the focus on the students as a central element for decision making related to the design and management of the new academic and administrative processes; and (3) the technical skills and leadership capacities to manage the internal processes that lead to an effective technological transformation of the university.

5. THEORETICAL MODEL OF THE DIGITAL TRANSFORMATION PROCESS OF A UNIVERSITY

The results in the previous section show the structural components of the digital transformation process of a university, which are described below. Figure 3 illustrates the mutual relationship between digital maturity and the digital transformation process.
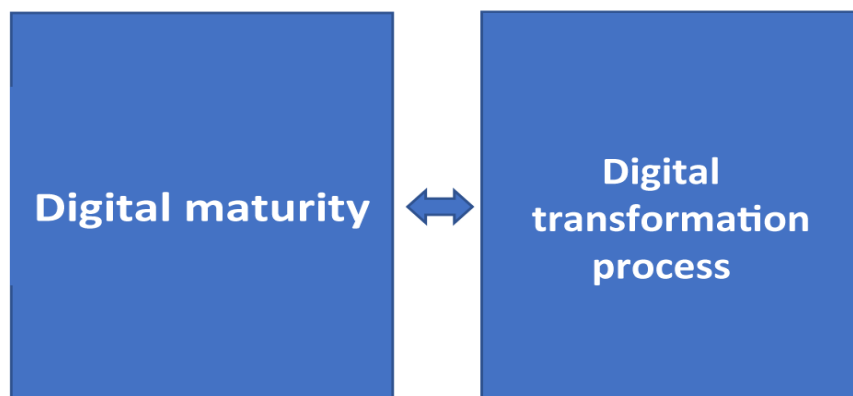

Figure 3. Recursion between the digital transformation process and the degree of digital maturity.

The model is based on the premise that any process aimed at the digital transformation of higher education institutions is consistent with the degree of digital maturity that it has reached. This means that there is a close and unequivocal relationship between "digital transformation" as a process and "digital maturity" as the result; however, both constructs feed each other constantly. As the transformation process determines the degree of maturity reached, this again impacts the process in search of new transformations. Figure 4 shows this recursive property.
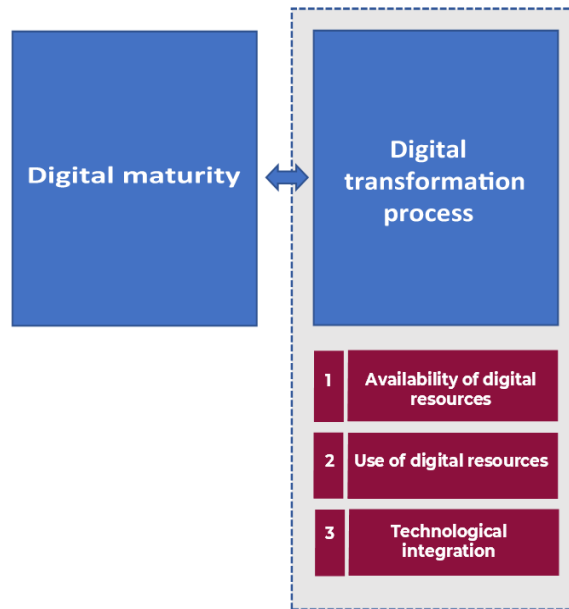
Figure 4. Phases of the digital transformation process of a university.

The digital transformation process is made up of three phases that represent a continuum, since the variations in the current situation will occur gradually as actions to increase the degree of digital maturity are carried out. As reflected in Figure 4, the three phases of the digital transformation process are: (1) availability of digital resources, (2) use of digital resources, and (3) integration of digital technologies.

Each of these phases impacts the digital maturity of the university according to the percentage contribution indicated in Figure 5.
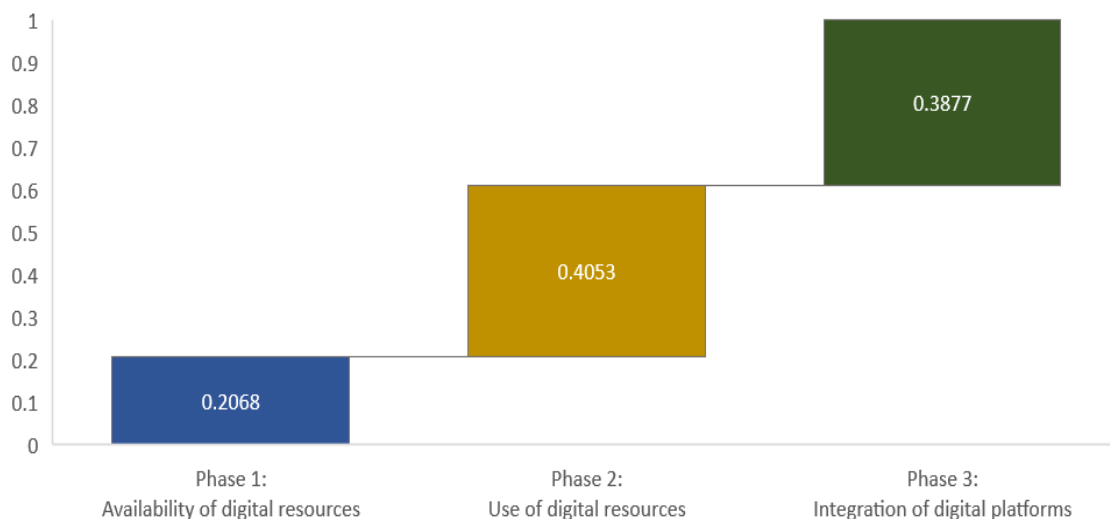

Figure 5. Percentage contribution of each phase of the digital transformation process to the digital maturity of a university.
Note: Analysis of data obtained from the questionnaire answered by the students.

883

The previous figure shows that the greatest contribution to the digital maturity of a university does not come from its financial resources or the available technological base, but from how it uses the available technological resources and its capacity to manage the integration of the various technologies.

For the three phases that the digital transformation process of a university goes through (according to experts), the initial 11 dimensions were reduced to nine dimensions (see Table 12). The distribution of the dimensions to each phase was carried out according to the nature of the factors that are implicit in each of them, which is described below in paragraphs 5.1, 5.2 and 5.3.

Table 12. Phases and dimensions of the digital transformation process of a university.

Phase	Dimensions
1. Availability of digital resources	1.1. Strategy and culture 1.2. Financial resources 1.3. Technological basis
2. Utilization of digital resources	2.1. Focus on the students 2.2. Teaching and learning processes 2.3. Economic and administrative processes
3. Integration of digital platforms	3.1. IT governance 3.2. Capabilities and skills 3.3. Internal process management

5.1. Phase 1: Availability of Digital Resources

Any digital transformation process should include the review and adaptation of the technical context that will increase the degree of digital maturity of the university. This requires the design of specific strategies supported by clear leadership, the conviction about the need to invest in equipment and infrastructure and being able to count on highly qualified personnel capable of managing the process. Consequently, three areas of influence are observed that feed the first phase of the process: strategy and culture, financial resources, and technological base, with the latter referring to equipment, infrastructure, connectivity, and technical support. This phase is consubstantiated with the strategic approach and organizational culture.

5.1.1. Dimension Strategy and Culture

Culture represents the strategic basis for the digital transformation of universities as it is related to the interactions between people and technologies to satisfy the requirements of people and society. This dimension includes the adoption and implementation of decisions related to university policies and strategies related to obtaining, using, and integrating digital technologies. The 'Strategy and Culture' dimension incorporates three indicators:

- Mission and vision statements that focus on the digital context
- Formulation of strategic objectives focused on information technology
- An organizational structure adaptable to the demands of the digital environment.

5.1.2. Dimension: Financial Resources

Financial management affects the way in which the digital transformation of any organization occurs, including higher education institutions, and represents the basis for improving internal processes and productivity, differentiating from the competition by providing a better customer/student experience. It helps organizations to stay ahead of the trends of the digital age both in terms of learning and administrative platforms; therefore, this second dimension includes the following indicators:

- Investment in learning platforms
- Investment in administrative technology platforms.

5.1.3. Dimension: Technological Base

For the descriptive purposes of the theoretical model of the digital transformation of a university, the technological base is constituted by the equipment, applications and infrastructures that allow the generation or improvement of the academic and administrative processes that are produced by the use of different technologies. The technological base is represented by the following components:

- Availability of a digitized library
- Availability of digital technologies in organizational processes
- Availability of a digital platform to manage student affairs
- ICT support to promote work groups
- Digital support for the student–director–secretary relationship
- Availability of quality technical support in digital processes.

5.2. Phase 2: Use of Digital Resources

For the purposes of the proposed model, the use of digital resources refers to the way in which the technological base obtained in the previous phase is used, both in terms of academic and administrative processes, and implies recognition of the potential of new technologies to generate and implement initiatives that favor the student experience, facilitate the management of internal processes, and increase competitiveness. This phase is consubstantiated with the use and exploitation of the technological base, with its fundamental elements of its focus on the student experience, the improvement of the teaching and learning processes, and the use of technological capacities for the greater effectiveness of the economic and administrative processes.

5.2.1. Dimension: Focus on the Student Experience

The digital transformation process must be based on the need to increase the centrality of the students to improve their experience in terms of academic and administrative matters that concern them and optimize communication aspects that allow them to offer timely and real information. Hence, the main focus of digitization is student satisfaction, and this premise must be internalized in decision-making processes. The following indicators correspond to this dimension:

- A comprehensive approach to the student experience.
- IT focus on student loyalty and university brand.
- Problem solving for students, with an IT approach.
- Accessible services anywhere and at any time.
- Digitization of the student life cycle.
- Incorporation of IT for student satisfaction and retention.
- Incorporation of IT for the continuity of studies.
- Integration of a student life project – teaching strategy.
- Improvement of contact points with students through ICT.

5.2.2. Dimension: Teaching-Learning Processes

The teaching-learning processes represent the core of the system that generates value for the student by involving the interaction between teachers and students with the mediation of digital technologies. Here lies the effectiveness of the pedagogical action and the social justification of the university in accordance with the new training scenarios and the requirements of the labor market. The following indicators are included in this dimension:

- Use of predictive data to anticipate student needs.
- Individualized counseling system.

885

- Academic and pedagogical support with a focus on information technology (IT).
- Labor internships and job search with a digital focus.
- Incorporation of IT in the student's study rhythm.
- Teaching model appropriate to the physical location of the student.
- Adaptation of the teaching model to the profile of each student.
- Application of ICT in the teaching-learning process.
- Incorporation of digital teaching strategies in pursuit of family integration.

5.2.3. Dimension: Economic-Administrative Processes

In the digital transformation model, economic-administrative processes play a fundamental role in ensuring the operational and financial sustainability of the university, maintaining flexibility to adapt to the socioeconomic conditions of students, providing study alternatives, optimizing the use of resources improving response time and facilitating the generation of useful information for the student. Along with the teaching-learning processes, economic-administrative processes impact the student experience and can be a determining factor in decisions about continuing studies. This dimension is substantiated with the following indicators:

- Digitized administrative processes
- Integration of the student's socioeconomic level with digital teaching strategies
- Recruitment of potential students through social networks
- Student loyalty strategies with a digital focus.

5.3. Phase 3: Integration of Digital Technologies

This last phase of the digital transformation process relates the internal capacities of the university with the changes that occur as a consequence of the techno-cultural evolution of society; In other words, it refers to the links between technology and the environment, including the development of capacities and the implementation of new proposals and initiatives aimed at improving institutional management, even though the reconfiguration of the classic organizational structures, always maintaining Focus on the student experience. This phase is consubstantiated with the competencies and capabilities to manage technology, its fundamental elements being IT governance, competencies and capabilities, and the management of internal processes.

5.3.1. Dimension: IT Governance

Computer governance is related to the ability to lead, on the one hand, the processes aimed at centralizing information to be able to understand and decode it to improve decision-making processes based on data from different sources; and on the other, from an external perspective, IT governance is related to the management of links with the different entities that make up the university ecosystem. In this sense, this dimension is essential in the digital transformation process as it is consubstantiated with the management and control of all processes mediated by information technology, which contribute to achieving strategic objectives. The indicators associated with IT governance are:

- Analysis of students' perceptions of social networks.
- Analysis of positioning indicators.
- Identification of points for improvement in digital services.
- Digital initiatives aligned with the corporate strategy.
- Promotion of projects on digital issues.
- Automation of teaching services aimed at students.
- Positioning through digital platforms.
- Relations with companies and corporations.

- Relations with communities and social groups.
- Relations with foundations/NGOs.
- Relations with international universities.
- Links with the educational community and professors from other universities.

5.3.2. Dimension: Competences and Capacities

This dimension covers the cognitive, emotional, and attitudinal skills required to integrate digital technologies and reduce the technological gap between the people who make up the various levels of the university. Competencies with a focus on digital technologies cover a wide range of capacities, including technical knowledge, continuous learning, collaborative work, leadership, resilience, information management, strategic vision and decision making, and focus on student/customer experience. The indicators of this dimension have been grouped as follows:

- Training focused on digital technologies.
- Training in digital pedagogical strategies.
- Tolerance to changes.
- Continuous learning ability.
- Promotion of collaborative learning through social networks.

5.3.3. Dimension: Internal Process Management

Finally, the management of internal processes covers all the processes that must be conducted to achieve the strategic objectives of the university in a context characterized using integrated digital technologies, both to support workflows and for making decisions related to improving performance and relations with students, teachers, administrators, and other stakeholders. This dimension incorporates the following indicators:

- Digital technologies in workflows.
- Technologies in back office optimization of the organization.
- Decision making that incorporates IT.
- Data-driven decision making.

The percentage contribution of each dimension to the digital transformation process of a university is shown in Figure 6.
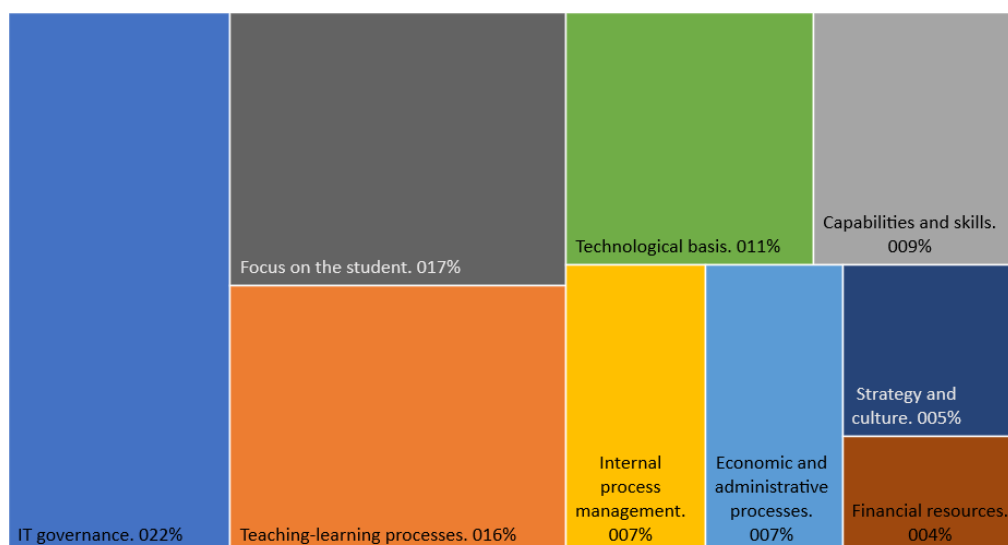

Figure 6. Dimensions of the digital transformation process and the percentage contributions to digital maturity.

The indicators associated with each of the dimensions that make up the theoretical model of the digital transformation process of a university are shown in Table 13.

Table 13. Matrix of indicators of the digital transformation process of a university and the weighted weights that should be used to determine the degree of digital maturity.

Phase of digital transformation	Dimension	Indicators	Weighted weights
1. Availability of digital resources (20.68%)	1.1. Strategy and culture (5.49%)	Organizational structure adaptable to digital	0.0191
		Strategic objectives with a focus on information technology	0.0180
		Mission and vision statements focused on digital	0.0178
	1.2. Financial resources (3.76%)	Investment in learning platforms	0.0190
		Investment in administrative technology platforms	0.0186
	1.3. Technological basis (11.43%)	Digital platform for student affairs	0.0193
		IT support to foster work groups	0.0192
		Digital support for the student–director–secretary relationship	0.0192
		A digitized library	0.0190
		Quality technical support for digital processes	0.0189
		Digital technologies present in organizational processes	0.0187
2. Use of digital resources (40.53%)	2.1. Focus on the students (16.8%)	Comprehensive approach to the student experience	0.0194
		Accessible services anywhere and at any time	0.0194
		Incorporation of IT for the continuity of studies	0.0188
		Improvement of contact points with students through ICT	0.0187
		IT incorporation for student satisfaction and retention	0.0186
		Solving problems for students, with an IT-based approach	0.0184
		Digitization of the student life cycle	0.0184
		Integration of a student life project – teaching strategy	0.0183
		IT focus on student loyalty and university brand	0.0180
	2.2. Teaching and learning processes (16.47%)	Academic and pedagogical support with a focus on IT	0.0189
		Labor practices and job searches with a digital approach	0.0187
		Application of ICT in the teaching and learning processes	0.0184
		An individualized counseling system	0.0182
		A pedagogical model appropriate to the physical location of the student	0.0182
		Use of predictive data to anticipate student needs	0.0181
		Incorporation of IT into the student's study rhythm	0.0181
		Incorporation of digital teaching strategies in pursuit of family integration	0.0181
		Adaptation of the teaching model to the profile of each student	0.0180
	2.3. Economic and administrative processes (7.26%)	Digitized administrative processes	0.0188
		Integration of the students' socioeconomic level with digital teaching strategies	0.0184
		Student loyalty strategies with a digital focus	0.0178
		Recruitment of potential students through social networks	0.0176
3. Integration of technological platforms (38.77%)	3.1. IT governance (21.96%)	Promotion of projects on digital issues	0.0189
		Relations with international universities	0.0189
		Relations with companies and corporations	0.0188
		Automation of teaching services aimed at students	0.0185
		Links with the educational community and professors from other universities	0.0185
		Digital initiatives aligned with corporate strategy	0.0184
		Relations with communities and social groups	0.0182
		Positioning through digital platforms	0.0181
		Identification of points of improvement in digital services	0.0180
		Analysis of positioning indicators	0.0178

Phase of digital transformation	Dimension	Indicators	Weighted weights
		Relationships with foundations/NGOs	0.0178
		Analysis of students' perceptions of social networks	0.0177
	3.2. Capabilities and skills (9.44%)	Continuous learning ability	0.0196
		Change tolerance	0.0195
		Training focused on digital technologies	0.0192
		Training in digital pedagogical strategies	0.0184
		Promotion of collaborative learning through social networks	0.0177
	3.3. Internal process management (7.37 %)	Decision making that incorporates IT	0.0187
		Digital technologies in workflows	0.0186
		Technologies in back-office optimization of the organization	0.0183
		Data-driven decision making	0.0181

Note: Data obtained from the questionnaire administered to students.

The theoretical model of the digital transformation process of a university is shown in Figure 7, and it shows that the foundation of this process is the generation of greater value for the student. As indicated by the experts consulted, no digitalization effort would make sense if it did not focus on the students' experience and the need to have clear, precise and timely information.
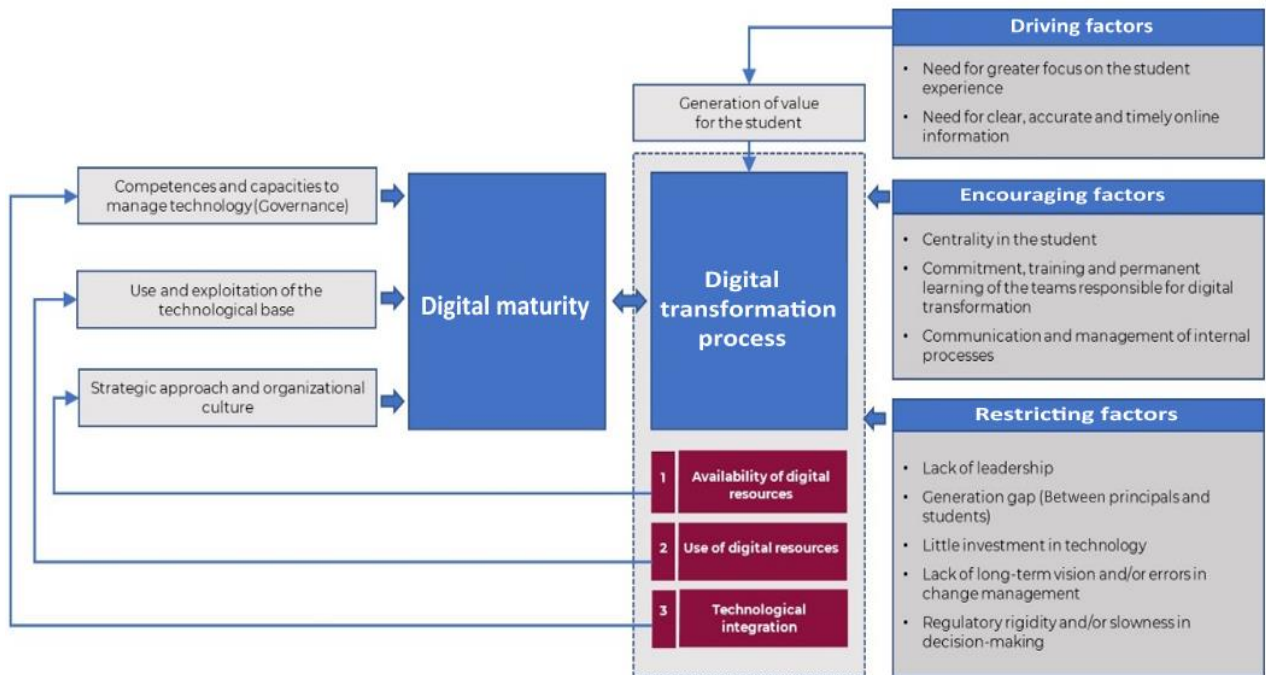

Figure 7. Theoretical model of the digital transformation process of a university.

6. DISCUSSION

Based on the results obtained, the digital transformation model of the Autonomous University of Chile reflects the close relationship between digital maturity and the generation of value for the students through the teaching and learning processes and the economic administrative processes, which are linked to: (1) the approach strategic and organizational culture; (2) the use and exploitation of the available technological base; and (3) the competencies and abilities that are demonstrated to manage the technology. These three elements are determinants of the success of the university's digital transformation process and require that the student be assumed as the center of attention in the decision-making process (student-centricity), but also requires commitment, training and the permanent learning of the people responsible for managing technological change, which in turn demands clear leadership, as

well as adequate communication and coordination between the academic administrative areas that are responsible for managing the institution's processes.

The preceding concept is encapsulated in the definition provided by Pelletier and Hutt (2021) who defined digital transformation as "a series of profound and coordinated shifts in culture, workforce, and technology that facilitate new educational and operational models. This transformation alters an institution's business model, strategic directions, and value proposition" (p. 30). This underscores the necessity for innovative leadership at all levels within the institution, demanding effective coordination among different units. The expansive and significant spectrum of technological change impacts higher education institutions and is particularly evident in the realms of values and operations. This has been corroborated by Núñez, Quirós, and Cerdá (2021) with explicit reference to the case of Chilean universities and aligns with the findings of this study.

Any effort to change toward the digitization of university systems and processes implies that the model to which it aspires has been previously recognized and is in harmony with the social mission of the university. This will not only boost the mechanisms that guarantee a higher educational quality but will also ensure a transformation process that takes into account the digital skills (current and desired) of students, teachers and those responsible for managing the incorporation of technology in academic administrative processes, the challenges posed by digitalization and consolidate regional, national and supranational alliances that serve as a support to initiate other disruptive processes to anticipate new scenarios derived from scientific technological advances in the global context.

The financial difficulties that a university may be going through, its cultural tradition, regulatory rigidity, the absence of a clear vision of what is to be achieved through the digital transformation process and the mistakes that can be made both in the change management and the implementation of new technologies are factors that could not only reduce the institutional capacity to implement technological changes, but could also have contradictory effects on the economic and social dimensions of the university's sustainability strategy.

On the other hand, the design of the model verifies what Xiao (2019) highlighted when he argued that digitalization, as perceived by universities in China and other countries, seems to be oriented toward the creation of digital campuses and the development of innovations in academic processes but lacks sufficient incentives for digital technologies to improve research capacity and serve a broader community. In fact, during the data collection process, none of the experts mentioned the improvement of scientific activity, one of the substantive activities of universities. This aspect was not reflected in any of the models that were used as a basis to build the theoretical model of digital transformation of the Autonomous University of Chile, which merits further studies to determine the reasons why, in the case of higher education, the transformation process seems to be delimited to the internal context of the institutions.

In the field of IT governance, which is the dimension of the transformation process that contributes the most to the digital maturity of a university (21.96%), it is necessary to elucidate how the digital structure of the institution aligns the strategic, technical and logistical needs with the redefinition of the roles of administrative staff, teachers and students, in order to promote continuous innovation of services and processes and create new student-centered digital learning spaces. This gives rise to future studies that try to elucidate what the potential problems are, the needs that arise in terms of the new technological interactions that will take place within the university, and the identification of the new opportunities offered by such links in the context of social responsibility.

7. CONCLUSIONS

Based on the findings presented in this study, the following conclusions are established:

1. The digital transformation model for the Autonomous University of Chile was designed based on the dimensions and factors that students and teachers rated as essential.

2. The digital maturity of the Autonomous University of Chile will be mainly determined by its way of using the available technological resources and its capacity to integrate the different technologies.

3. Computer governance is the dimension that contributes the most (21.96%) to achieving the digital maturity of the university. Curiously, investment in administrative and learning technology platforms only contributes 3.76% of the digital maturity achieved.

4. The digital maturity of the university is a variable closely interrelated with the digital transformation process, which is influenced by: (1) the skills and abilities to manage technology, (2) the use and exploitation of the technological base, and (3) the organizational culture and strategic focus of the institution.

5. The factors that facilitate the process of digital transformation at the university are: (1) its focus on the students; (2) permanent learning and the commitment shown by the entities responsible for carrying out said process; and (3) the effective coordination and management of the processes carried out in the areas involved.

6. The main factors that could hinder the implementation of the digital transformation process are: (1) the lack of leadership and a long-term vision; (2) slowness in decision-making processes; (3) the generational gap between teachers and students; and (4) little investment in the technological base.

8. RECOMMENDATIONS

Due to the exploratory level of this research, it is recommended that new studies be carried out to verify the consistency, reliability, and validity of the digital transformation model of the university using structural equation modeling. Even if the model presented in this article is validated, it is recommended that its impact on students be determined before its implementation; for this purpose, the Student Satisfaction Index model can be used, which was proposed by Turkyilmaz, Temizer, and Oztekin (2018).

Additionally, considering the findings, new questions arise that need to be answered from a scientific perspective. For example, a future area of research could be to analyze the influence of organizational routines in the adoption of a culture in accordance with the demands of the digital ecosystem in the context of higher education and to evaluate the potential impact of digital transformation on the sustainability of the University.

From a non-scientific perspective, it is suggested that the people responsible for managing the implementation of the digital transformation model at the university consider the influence of power relations during the transition toward digital transformation since this will affect the coordination of internal processes associated with information governance, the behaviors of people with technical and management responsibilities, the performance of teachers, and the confidence of students regarding future academic and administrative processes.

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APPENDIX

Appendix I. Interview protocol.

1. In your opinion, which areas are most likely to be digitized to add value to the university and its students?

2.   Of the areas you have named, which would be the most important to you and why?

3.   In your opinion, which activities carried out at the university will have a greater impact on student satisfaction when digitized? Could you briefly describe the impact it would have?

4.   As you know, we are designing a theoretical model to measure the degree of digital maturity of a university. Based on your experience, what do you think are the factors that determine this degree of maturity?

5.   We understand that many universities have not yet started a modernization process oriented toward their digital transformation. Do you think that the conditions are currently right for Chilean universities to start this process?

6.   What do you think is the area that should lead digital transformation projects at the university?

7.   From your point of view, what are the reasons that could drive the digital transformation of a university? Would there be differences between public and private universities?

8.   Conversely, what are the reasons that could make this transformation difficult? Would there be differences between public and private universities?

9.   How do you think innovation and the integration of digital technologies could be promoted in the various areas of the university?

10. Do you want to add any other comments on the possible impact of digital transformation on Chilean universities?