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Digital transformation and student satisfaction at the Autonomous University of Chile

Transformación digital y satisfacción estudiantil en la Universidad Autónoma de Chile

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ABSTRACT

The great advances that derive from the technological revolution 4.0 have permeated higher education institutions, which have been forced to initiate extensive transformation processes that consider the integration of digital technologies to guarantee student satisfaction, maintain their social validity and ensure their sustainability. In this article, focused on the case of the Autonomous University of Chile, the existence of causal relationships between the Digital Transformation model of that University and the Student Satisfaction Index model proposed by Turkyilmaz, Temizer and Oztekin (2018) is demonstrated. The objective of the research was to determine the impact of the digital transformation on the student's satisfaction of that University. The structural equation modeling technique was applied, using the data obtained from a questionnaire applied to 313 students at that University in the month of May 2023. The analyzes carried out empirically validated the proposed theoretical model, demonstrating that perceived quality is the variable that has the greatest effect on student satisfaction, and finding that the expectations created regarding the

results of the digital transformation of the University have a negative influence on the satisfaction; In other words, the higher the expectations about digital transformation, the more difficult it will be to satisfy students and achieve their loyalty to the institution.

Keywords. digital transformation; higher education; student satisfaction, loyalty, structural equation

RESUMEN

La revolución tecnológica 4.0 está obligando a las Universidades a iniciar amplios procesos de transformación que consideren la integración de las tecnologías digitales como vía para garantizar la satisfacción y lealtad de los estudiantes, mantener su vigencia social y asegurar su sostenibilidad. En este artículo, enfocado al caso particular de la Universidad Autónoma de Chile, se demuestra la existencia de relaciones de causalidad entre el modelo de Transformación Digital de esa Universidad y el modelo de Índice de Satisfacción del Estudiante propuesto por Turkyilmaz, Temizer y Oztekin (2018). El objetivo de la investigación fue determinar el impacto de la transformación digital en la satisfacción de los estudiantes de esa Universidad. Se aplicó la técnica de modelado de ecuaciones estructurales, utilizando datos obtenidos de un cuestionario aplicado a 313 estudiantes en el mes de mayo de 2023. Los análisis validaron empíricamente el modelo teórico propuesto, demostrando que la calidad percibida es la variable que mayor efecto tiene sobre la satisfacción de los estudiantes, y hallando que las expectativas respecto a los resultados de la transformación digital universitaria influyen de forma negativa en la satisfacción; es decir, que mientras mayores sean las expectativas respecto a la transformación digital, más difícil será satisfacer a los estudiantes y lograr su lealtad con la institución.

Palabras clave. Transformación digital, educación superior, satisfacción estudiantil, lealtad, ecuaciones estructurales

INTRODUCTION

The new paradigms that emerge from digital technologies are forcing higher education institutions to rethink their future and the way to maintain their validity in a world in a constant process of transformation, it is not easy to part with a tradition to address new dynamics that ensure long-term sustainability, which can only be achieved if we act in harmony with the profound changes that are taking place in the social environment.

The complexity of the aspects that intervene in the digital transformation has been argued by Rossmann (2019) when pointing out the need to develop a set of capacities linked to leadership, the market, operations, people, culture, governance, and technology. Other authors relate digital transformation to four categories of factors: organizational values (culture), management capacity, organizational infrastructure, and workforce capabilities (Muehlburger, Rückel & Koch, 2019); but the high failure rate in digital transformation projects (87.5%) has also been documented, mainly due to the formulation of unrealistic expectations, governance errors and limited scope (Wade & Shan, 2020).

In this sense, in the context of higher education institutions, digital transformation can be understood as a deep and accelerated transformation of processes, skills and models to take advantage of the changes and opportunities offered by digital technologies (Demirkan, Spohrer & Welser, 2016). It has also been understood 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, which begins with the use of digital technologies and then evolves towards the holistic digital transformation of the organization (Teichert, 2019). This leads to a new global and intensely

interconnected scenario that highlights the importance of ideas, innovation, and relationships (Kelly, 1999).

However, the dynamic and evolutionary nature of digital transformation leads to understanding the concept of maturity of said process, understood as an integrated framework that allows measuring the way in which the key capabilities that lead to success in the new digital era are developed (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) and satisfy, in the first instance, the needs and expectations of the users, in this case, of the university students who become the reason and the meaning of any profound change of transformation in the processes.

This is how, in the specific case of the Autonomous University of Chile (UA), a digital transformation model adapted to the cultural and structural particularities of that institution was designed; However, to guarantee the success of its implementation, it is not enough to identify the dimensions and indicators that structure this model of profound change, but it is also necessary to demonstrate the causal relationships between said model and student satisfaction, understanding that any transformation effort makes sense to the extent that it manages to positively influence the student body.

In response to this need, the objective of the research was to determine the impact of digital transformation on the satisfaction of students at the Autonomous University of Chile. For this purpose, the digital transformation model designed specifically for that University was studied in terms of its impact according to the Student Satisfaction Index model, which was created by Turkyilmaz, Temizer and Ozteki (2018).

The two theoretical models used for the development of the research are described below.

DESCRIPTION OF THE MODELS UNDER ANALYSIS

Digital Transformation Model of the Autonomous University of Chile (DTM)

The Digital Transformation model of the Autonomous University of Chile was created based on a previous study that made it possible to identify and direct the mechanisms that ensure a transformation process that takes into account the digital skills (current and desired) of the students, of the teachers and those responsible for managing the gradual incorporation of technologies in academic-administrative processes, and that also allows anticipating the new scenarios that derive from scientific-technological advances in the global context with a view to achieving a higher educational quality .

The model assumes that there is a close and unequivocal relationship between "digital transformation" understood as a process, and "digital maturity", understood as a result. Both constructs feed each other by understanding that the transformation process determines the degree of maturity reached, which once again impacts the process in search of new transformations. In this regard, “digital transformation” refers to the process by which organizations adopt digital technologies to improve their operations, services, and business models. This process involves profound changes in the culture, structure, and processes of the organization. On the other hand, “digital maturity” relates to the degree to which an organization has successfully implemented digital transformation and effectively integrated technology into all aspects of its operation. In this way, it is understood that an organization with high digital maturity is well positioned to take full advantage of the opportunities offered by the digital era, among which the optimization of processes, the improvement of the customer experience and continuous innovation stand out.

For the Autonomous University of Chile, attaining a high level of digital maturity would primarily result in an increased ability to fulfill student expectations and leverage the opportunities presented

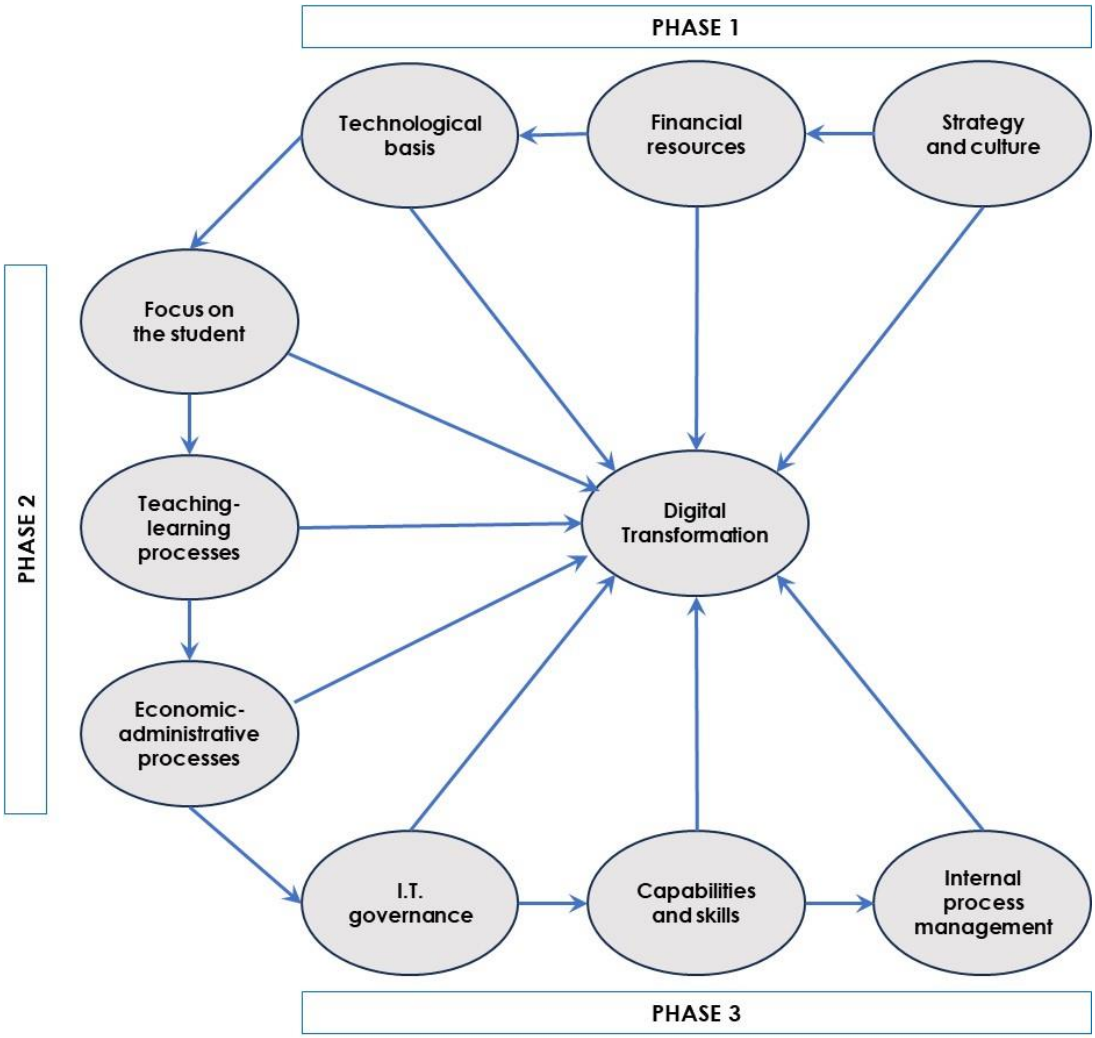
by emerging technologies to innovate academic and administrative processes. To this must be added the possibility of achieving a better competitive positioning at a national and international level, which contributes to attracting and retaining talented students, professors, and researchers.,

The structure of this digital transformation model is made up of nine variables and 54 indicators that resulted from operationalizing a solid theoretical body represented by the contributions of Catlin, Scanlab, and Willmott (2015), Crespo, and Pariente (2018), Furedi (2011), Gobble (2018), Salinas, and Vio (2011), Sánchez, and Fernández (2010), and Valdez-de-León (2016),

The resulting theoretical model was subjected to a validation process by performing an exploratory factor analysis (EFA) to determine the structures of the underlying factors; that is, to identify the observed variables that were associated with each latent variable, and then, through a confirmatory factor analysis (CFA) that allowed to verify the validity of the factorial structure and demonstrate that all the variables and their corresponding dimensions form a robust construct that explains the phenomenon studied.

The model is made up of nine dimensions distributed in three constitutive phases of the digital transformation process (Figure 1).

Figure 1. Graphic representation of the Digital Transformation Model of the Autonomous University of Chile



Each of the constructs that make up the Digital Transformation model of the Autonomous University of Chile is described below.

Strategy and culture represent the basis for the digital transformation of the University, being related to the interactions between people and technologies to satisfy the requirements of people and society. This dimension includes the adoption and implementation of university policies and strategies related to the acquisition, use and integration of digital technologies. The relevance of these concepts has been exposed by Ghosh et al. (2022) when stating that the development of an organization's digital transformation capacity involves reconfiguring existing capabilities, which depends on the organizational culture. Similarly, from the strategic perspective, Martínez-Caro et al. (2020) understand culture as a means through which the organization can begin to plan digital strategies in an environment characterized by rapid changes. The above is related to what was pointed out by Warner and Wäger (2019), who understand digital transformation as a continuous process for the strategic renewal of business models, the collaborative approach and organizational culture. This construct is made up of the following indicators: mission and vision focused on the digital context, strategic objectives focused on information technologies, and the existence of an organizational structure adaptable to the demands of the digital environment.

Financial resources are the base for improving internal processes and productivity, to provide a better student experience. In this regard, Parker (2013) has compiled evidence that the cost and operational efficiency strategies of universities are being facilitated by financial performance accountability systems, having noted that the lack of sufficient financing is a factor that could be slowing down the digital transformation of universities (Rodríguez-Abitia and Bribiesca-Correa (2021). This aspect represents a great challenge for higher education institutions, who must adapt their investment decisions according to their own financial capabilities, which implies a commitment to resource management in pursuit of the modernization of their technological infrastructure (Burgos and Branch, 2021).This dimension includes investments in learning platforms and administrative technology platforms.

Technological basis is constituted by the set of equipment, applications and infrastructures that allow the generation or improvement of the academic and administrative processes that derive from its institutional mission, and that are produced using different technologies. The utilization of digital technologies, spanning organizational and economic realms, along with the introduction of novel products and services to students, significantly impacts three key dimensions: the evolution of the value proposition, the value creation model, and the customer interaction model (Pousttchi et al., 2019). Consequently, as highlighted by Krasota et al. (2020), the core of digital transformation appears to hinge on the advancement of a technological framework, the ramifications of which extend progressively across both internal organizational dynamics and the served market landscape.

The construct **Focus on the student experience** refers to the capacity of the educational institution to increase the centrality in the student to improve their experience in terms of academic and administrative matters that concern them and optimize the communicative aspects that allow them to offer information timely and true. From a conceptual point of view, the student experience is defined as the set of perceptions they receive when consuming products and services that are not only educational, but that are provided by the educational institution (Cano et al., 2021). Consequently, focusing on the student experience requires understanding their needs and analyzing how they interact with the educational institution in terms of the products, systems and services involved.

Teaching-learning processes represent the core of the system that generates value for the student. It includes the interaction between teachers and students with the mediation of digital technologies. Teaching-learning process is a backbone of any educational system, and the entry of digital technologies into these processes has increased the effectiveness of teachers and students (Hafeez, 2021). The complexity underlying these processes lies in the fact that, as educational psychology suggests, learning processes take place while people participate within social communities (Bordogna and Albano, 2001). Therefore, the cognitive impact that each

student receives is the global result of interactions with their environment, including teachers, other students and facilities of the educational institution. This dimension supports the effectiveness of the pedagogical action and the social justification of the university in accordance with the new educational scenarios and the requirements of the labor market.

Economic-administrative processes make it possible to ensure the operational and financial sustainability of the university, maintain flexibility to adapt to the socioeconomic conditions of the students, provide study alternatives, optimize the use of resources, improve response time, and facilitate the generation of information useful for the student. Generally, these processes are understood as the set of tasks necessary to request, claim, register, pay, reserve or be evaluated to achieve a particular objective (Coughlan and Lister, 2018).Together with the teaching-learning processes, the economic-administrative processes are determinants of the quality of university services (Vrielink et al., 2019), impact the student experience and can be a determining factor in decisions about the continuation of studies. For this reason, universities are expected to improve their processes by determining which ones add the most value to the student, in addition to their contribution to improving workflows and information (Klein et al., 2022).

IT Governance refers to the University's ability to lead processes aimed at centralizing information to be able to understand and decode it to improve decision-making processes. In these organizations, the technological infrastructure is made up of a variety of applications, platforms, academic systems and heterogeneous technologies that support academic and administrative processes, requiring for its proper management a set of structures, processes and mechanisms, which are integrated into the concept of IT Governance (Bianchi and Sousa, 2016). This variable is consubstantiated with the management and control of all the processes that are mediated by information technologies and that contribute to achieving the strategic objectives of the university.

Competences and Capabilities encompasses the cognitive, emotional, and attitudinal skills that are required to integrate digital technologies and reduce the technological gap between the people that make up the various levels of the university. Conceptually, these skills take the form of forms of action that the organization values, including the ability to think critically, maintain an ethical disposition, and be able to understand a plurality of perspectives on a given problem and its possible solutions (Boni et al. 2010). In the realm of digital transformation, it encompasses more than just technical know-how; it involves leveraging expertise to enhance an organization's core capabilities, seamlessly integrating diverse technologies, and harnessing technological resources to fulfill strategic goals (Salisu and Abu Bakar, 2019).

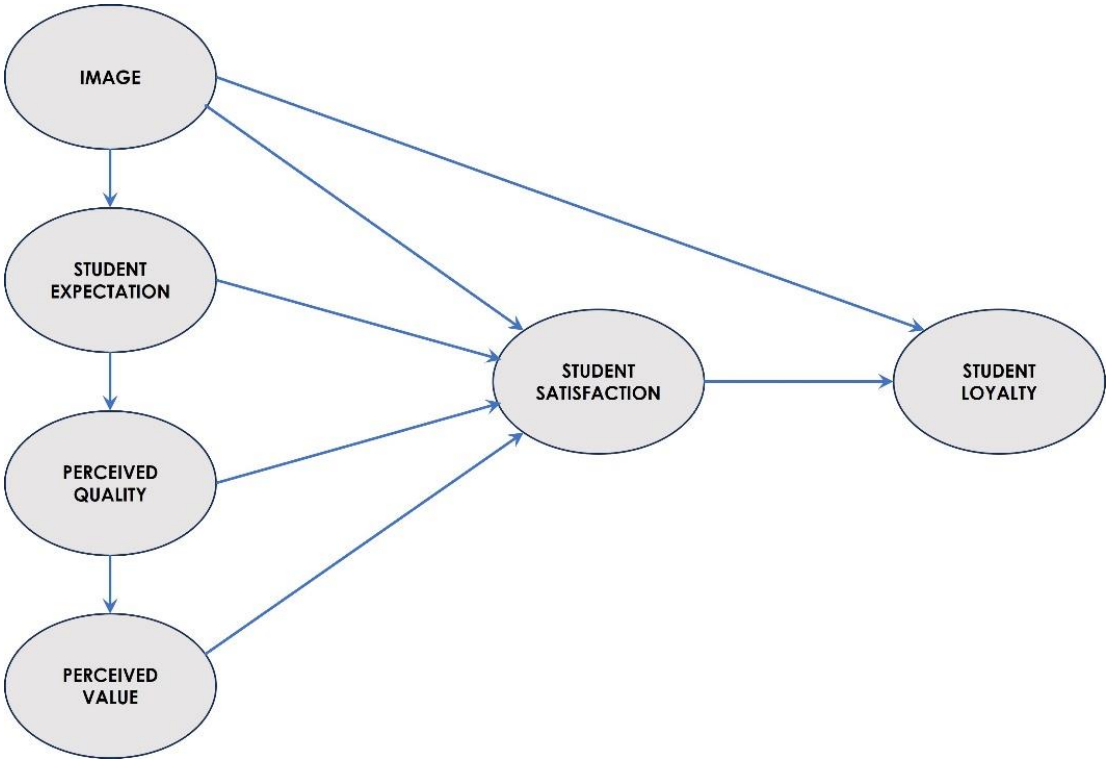
Finally, the **Management of internal processes** covers all the processes that must be carried out to achieve the strategic objectives of the university in a context characterized by digital technologies, both to support workflows and for related decision-making with the improvement of performance and relationships with students, teachers, administrative staff, and other interest groups. Internal processes can be categorized into substantive, strategic, and support processes. It is essential not only to manage these processes themselves but also to address the interrelations between them (Ortiz-Pérez et al., 2015).The importance of managing internal processes lies in its contribution to measuring the organization's performance in terms of its ability to satisfy the requirements of interested parties, and providing useful feedback to determine the extent to which the University is achieving its objectives, meeting the established standards and maintains the ability to improve and excel (Al-Omari et al., 2020).

Student Satisfaction Index Model (SSI)

The Student Satisfaction Index Model (SSI) proposed by Turkyilmaz, Temizer, and Oztekin (2018), was based on the structure of the European Customer Satisfaction Index (ECSI) model. The main difference between both models is that the SSI model omits the relationship between expectations and perceived value since, according to its creators, it has been shown that there is no significant relationship between these two constructs.

The structure of the SSI model, understood as the set of factors and hypothetical relationships between them, is shown in Figure 2.

Figure 2. Graphic representation of the Student Satisfaction Index Model (SSI)



Source: Adapted from Turkyilmaz, Temizer, and Oztekin, (2018) p. 123

Each of the constructs that make up the Student Satisfaction Index Model is described below:

Student expectations refer to the outcome of students' prior experiences with the academic and non-academic services they receive. This construct evaluates the expectations of educational quality, social environment, fulfillment of educational and professional goals, and managerial and administrative excellence. As in the case of the image, it is expected that the student's expectations have a direct relationship with satisfaction.

Perceived quality refers to the evaluation that students make of their recent experiences at the university. This construct includes the perceived educational quality, the contribution of the social environment to achieve the goal, managerial and administrative excellence, and the fulfillment of educational and professional goals. It is expected that perceived quality has a positive influence on student satisfaction.

Perceived value refers to the level of quality of service that students perceive in relation to the price they pay. As in the previous constructs, the perceived value is expected to have a positive impact on satisfaction.

The student satisfaction construct evaluates the level of general satisfaction of the students, the fulfillment of their expectations, and the performance of the university versus what they consider to be an ideal university. In other words, it indicates to what extent students are satisfied and to what extent their expectations are being met. It is expected that student satisfaction has a positive effect on their loyalty towards the University.

Finally, Student loyalty measures the intention of students to select the same university, recommend it to other people, or drop out when possible. Turkyilmaz, Temizer, and Oztekin (2018)

consider that loyalty is the fundamental factor of the SSI model, hoping that a better image of the University and a higher level of student satisfaction will increase loyalty towards the educational institution.

Having described the two models that support the study, Figure 3 shows the hypothetical relationship between them, which will be subject to empirical validation using the structural equations method.

Figure 3. Hypothetical relationship between Digital Transformation Model of the Autonomous University of Chile (DTM) and Student Satisfaction Index Model (SSI).

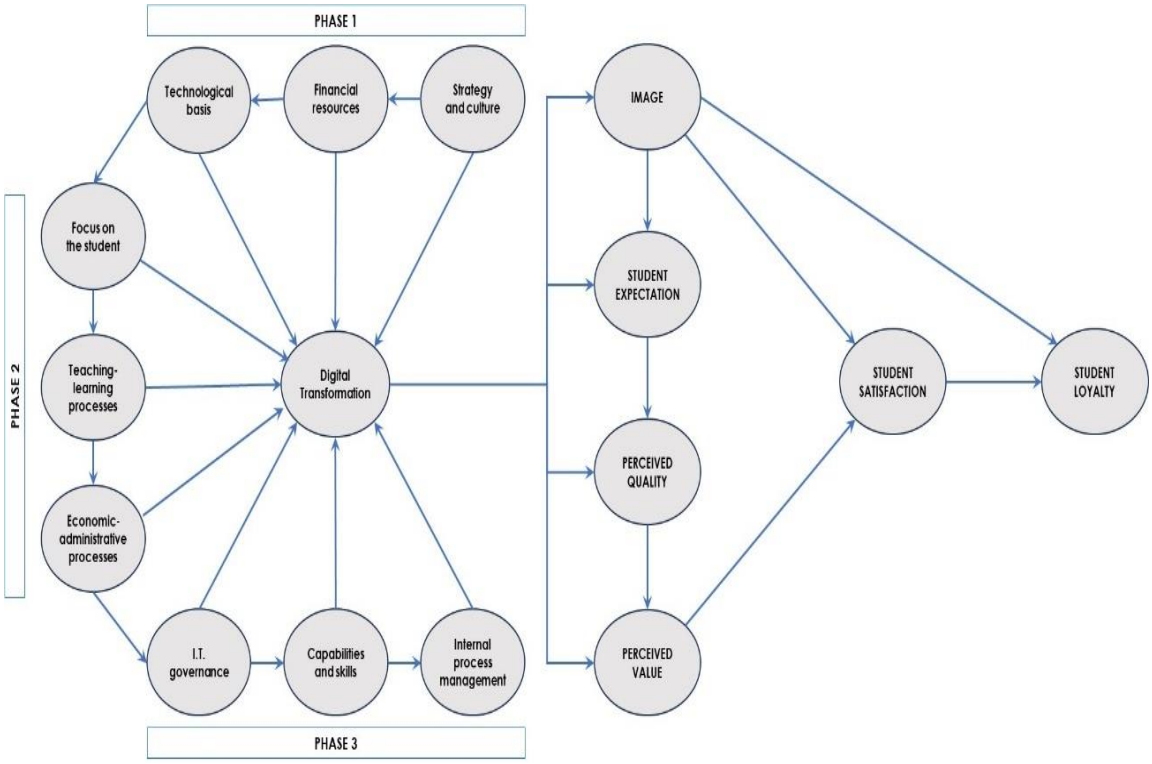


Figure 3 shows how the digital transformation of the Autonomous University of Chile would directly impact the constructs: "image", "student expectations", "perceived quality" and "perceived value"; and, indirectly, in “satisfaction” and “loyalty”.

METHODOLOGY

To determine the impact of university digital transformation on the satisfaction of the students at the Autonomous University of Chile, the structural equation modeling technique was applied through factor analysis, which is considered the quintessential technique for validation of theoretical constructs (Pérez-Gil, Chacón, & Moreno, 2000). Conceptually, factor analyzes have two modalities: Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA).

The Exploratory Factor Analysis (EFA) had the purpose of verifying the theoretical structure of the data, identifying the dimensions or latent variables that underlie it for explain a certain phenomenon, in this case, the impact of the digital transformation of the Autonomous University of Chile on student satisfaction.

For this, six dimensions are defined a priori (image, student expectations, perceived quality, perceived value, satisfaction, and loyalty). Exploratory Factor Analysis was used to statistically validate each dimension, verifying the internal consistency of each construct.t.

Each variable or indicator was measured through a questionnaire structured in six sections and 31 questions to be answered using a ten-level semantic scale through which it was desired to know how much the student agreed with each of the aspects raised. The amplitude of the scale ranged from the value 1, which means the least degree of agreement ("totally disagree"), to the value 10: the highest level of agreement with the phrase or aspect evaluated ("totally agree"). Only in section five, where Satisfaction is explored, the meaning of the scale was different since the value 1 meant “totally dissatisfied” and the value 10: “totally satisfied”.

The factorial method chosen for this analysis was Principal Component Analysis since the variables or indicators were measured through a ten-level ordinal scale. The rotation method used is "Varimax", which rotates the axes of the factors orthogonally, making them have a 90º angle between them, which makes it easy to interpret the results.

Before applying the Exploratory Factor Analysis, it was explored whether the conditions for its application were met; For this, the Kaise-Meyer-Olhin (KMO) test and the Bartlett Test of sphericity were used.

The KMO test measures the proportion of variance in variables that is caused by underlying factors. Values close to one are considered adequate (KMO between 0.7 and 0.8), and meritorious when they exceed the value of 0.8 or are close to 1 (Kaiser and Michael, 1975), while Bartlett's sphericity test indicates whether the model variables are uncorrelated, so the null hypothesis should be rejected ($p < 0.01$) to use factor analysis.

For Confirmatory Factor Analysis, even though there is no agreement on the matter, it is recommended that the sample size be 10 to 20 cases for each item or variable (Thompson, 2004). Other authors point out that the sample size should not be less than 200 cases (Lloret-Segura et al., 2014). In this study, the sample size was 313 cases, indicating, in principle, that the sample size was adequate to apply a CFA.

All dimensions are made up of nine variables or indicators, being greater than three indicators which, according to the literature, is the minimum required for this analysis (Batista-Foget & Coenders, 2000).

Another requirement to be able to use this model is the assumption of multivariate normality. To verify this assumption, the Kolmogorov-Smirnov normality test was used. This statistical test has as null hypothesis: H0: The variable follows a normal distribution, $X \sim N(\mu, \sigma 2)$. For a significance level $\alpha = 0.05$, if the p-value associated with the test is less than 0.05, the null hypothesis is rejected, concluding that the variable does not behave as a normal distribution.

RESULTS

Exploratory Factor Analysis

Below, Table 1 shows the results obtained for each of the dimensions of the Student Satisfaction Index model, proposed by Turkyilmaz, Temizer, and Oztekin (2018).

Table 1. KMO and Bartlett's Sphericity tests

Dimension	KMO[1]	Barlett test[2]	
		Chi-squared	p-valor
1. Image of the University	0,812	823,196	0,000
2. Student expectations	0,899	1.565,79	0,000
3. Expected quality	0,933	1.703,40	0,000
4. Expected value	0,759	664,782	0,000
5. Satisfaction	0,899	1363,754	0,000
6. Loyalty	0,738	647,010	0,000

Note: (1) Kaiser-Meyer-Olkin Measure of Sampling Adequacy
(2) Bartlett's Sphericity test

In all dimensions, the Barlett test rejects the null hypothesis, indicating that the variables that make up each dimension are related.

In relation to the KMO test, all the values are greater than 0.7; minimum value required, some of them being around 0.9. This shows that factor analysis can be used to explain the dimension and that the data in each dimension meet the theoretical assumptions for the application of factor analysis.

Dimension 1: Image of the University

Initially, the Principal Component Analysis (PCA) was applied to the variables that make up this dimension and the most important factors were extracted; those that had an eigenvalue greater than or equal to one, to verify how many factors are required to explain the dimension satisfactorily.

Table 2. Total Explained Variance - Image of the University

Components	Initial eigenvalues			Rotation		
	Total	% variance	cumulative variance %	Total	% variance	cumulative variance %
1	3,323	66,468	66,468	3,323	66,468	66,468

As a result of the PCA, it is observed that a single factor is sufficient to describe the dimension, Image of the University, explaining 66.47% of the total variability.

Below, in Table 3, the factorial coordinates, or "loads" of each variable in this factor are shown.

Table 3. Component Matrix - University Image

Nº	Indicator	Component
		1
1.1	Interest in meeting student requirements	0,840
1.2	Continuous commitment to innovation	0,859
1.3	Community valuation and recognition	0,780
1.4	Personal and professional prestige	0,798
1.5	Social environment of the University	0,797

Note: All the indicators refer to the Impact of the Digital Transformation of the University in each of the aspects evaluated in the "Image of the University" dimension.

As could be observed in the previous table, all the coefficients are greater than or equal to 0.8, indicating that all the variables are of great importance in the explanation of this dimension, which have similar and positive magnitudes; that is, the greater the perception of the Digital Transformation (DT) of the university, the better will be the Image that it transmits to the students. The most important aspects are the university's continuous commitment to Innovation (0.859) and the interest in meeting student requirements, timely and adequately (0.840).

Dimension 2: Student expectations

This dimension was made up of seven variables, all of them associated with the student's vision of the change in the university because of TD process in it.

When applying the factorial analysis, the results shown in Table 4 were obtained:

Table 4. Total Explained Variance - Student expectations.

Components	Initial eigenvalues			Rotation		
	Total	% variance	cumulative variance %	Total	% variance	cumulative variance %
1	4,841	69,163	69,163	4,841	69,163	69,163

About 70% of the total variability of this dimension is explained by the variables that make it up, so a single factor is enough to analyze it.

Next, Table 5 presents the coordinates of the variables on the factor.

Table 5. Components Matrix - Student expectations

Nº	Indicator	Component 1
2.1	Access to academic and administrative history	0,808
2.2	Ease of use of administrative processes	0,835
2.3	Advice and personalized teaching[1]	0,842
2.4	Integration to work groups and research networks	0,877
2.5	Access to online learning resources[2]	0,826
2.6	Communication with teachers and administrative staff	0,841
2.7	Ease of finding employment	0,789

Note: All refer to the Impact of the Digital Transformation of the University (DT) in each of the aspects evaluated in the "Student expectations" dimension.

(1) I will have personalized advice and the teaching model will be appropriate to my academic and socioeconomic profile

(2) I will be able to access, whenever I want, a digitized library and other online learning resources.

All the aspects that make up this dimension have a positive charge on the factor, with magnitudes greater than 0.8; except for the variable "Ease of finding employment" (0.789). This indicates that it is appropriate to consider all variables as components of the Student Expectations construct.

Dimension 3: Expected quality

The total explained variance of the product factor of applying the PCA to the data is presented in Table 6.

Table 6. Total Explained Variance - Expected quality.

Components	Initial eigenvalues			Rotation		
	Total	% variance	cumulative variance %	Total	% variance	cumulative variance %
1	5,061	72,298	72,298	5,061	72,298	72,298

The variables that make up the Expected Quality explain more than 70% of the total variability of this factor (72.3%). In other words, the selected variables make up a single construct.

Next, Table 7 presents the resulting component matrix.

Table 7. Components Matrix - Expected quality

Nº	Indicador	Componente 1
3.1	Improvement in academic performance	0,810
3.2	Flexibility in the hours of administrative requests[1]	0,839
3.3	Efficiency and speed in administrative processes	0,853
3.4	Integration to work groups and research networks	0,901
3.5	Access to online learning resources[2]	0,904
3.6	Communication with teachers and administrative staff	0,832
3.7	Ease of finding employment	0,807

Note: All refer to the Impact of the Digital Transformation of the University (TD) in each of the aspects evaluated in the "Expected quality" dimension.
(1) I will not have to limit myself to the working hours of the faculty to request grades or my academic record

All the variables of the factor have a positive impact and with significant magnitudes greater than 0.8. The most relevant aspects to explain the Expected Quality construct are access to online learning resources (0.90) and integration into work groups and research networks (0.90).

Dimension 4: Expected value

The Expected Value dimension is made up of three variables. Below, Table 8 presents the results of the factorial analysis, starting with the variability explained by the relevant factors.

Table 8. Total Explained Variance - Expected value.

Components	Initial eigenvalues			Rotation		
	Total	% variance	cumulative variance %	Total	% variance	cumulative variance %
1	2,571	85,696	85,696	2,571	85,696	85,696

As in the previous dimensions, only a single factor is necessary to explain this construct, since the first factor explains 85.7% of the total variability.

Next, Table 9 presents the structure of this dimension; that is, how the variables contribute to the formation of the factor.

Table 9. Components Matrix - Expected value

Nº	Indicators	Component 1
4.1	Quality of Education, price/quality ratio	0,933
4.2	Quality of Services, price/quality ratio	0,920
4.3	Professional prestige when studying and graduating[1]	0,923

Note: All refer to the Impact of the Digital Transformation of the University (TD) in each of the aspects evaluated in the "Expected value" dimension.
(1) Professional prestige that I will obtain by studying and graduating from this University, the relationship will be better: "price/value"

All the variables have positive and large-magnitude coordinates, greater than 0.90; indicating that all aspects considered in this construct have equal importance in its composition and are relevant to explain the expected value.

Dimension 5: Student Satisfaction

This dimension was made up of five variables or indicators. The following table (Table 10) presents the variability explained by the relevant factors.

Table 10. Total Explained Variance - Student Satisfaction

Components	Initial eigenvalues			Rotation		
	Total	% variance	cumulative variance %	Total	% variance	cumulative variance %
1	4,039	80,783	80,783	4,039	80,783	80,783

The table above shows that a single factor is relevant or sufficient to describe this dimension, since it explains 80.8% of the total variability; noting that all the variables make up a single construct.

Next, in Table 11, the structure of this factor will be explored.

Table 11. Components Matrix - Student Satisfaction

Nº	Indicator	Component 1
5.1	Satisfaction with administrative processes	0,893
5.2	Satisfaction with the teaching-learning process	0,913
5.3	Satisfaction with Access to information and services	0,903
5.4	Satisfaction with Communication with teachers[1]	0,890
5.5	Satisfaction with student expectations[2]	0,895

Note: All refer to the Impact of the Digital Transformation of the University (TD) on the Satisfaction of each of the aspects evaluated.
(1) Satisfaction with communication with teachers and staff working in the academic field
(2) To what extent will the Digital Transformation of the Autonomous University allow you to meet your expectations as a student and future professional?

The coordinates of the variables on the factor are all positive and of relevant magnitude, like each other; Satisfaction with the teaching-learning process being the most relevant (0.913). This shows that all the variables present in this dimension are part of a single construct.

Dimension 6: Student Loyalty

In this dimension, four variables were considered. The variable related to the change of university if given the opportunity, despite perceiving the benefits of DT, presents a "meaning" contrary to the rest of the variables; so, it was necessary to recode it. Next, Table 12 shows the Variance explained in this dimension.

Table 12. Total Explained Variance - Student Loyalty

Components	Initial eigenvalues			Rotation		
	Total	% variance	cumulative variance %	Total	% variance	cumulative variance %
1	2,536	63,405	63,405	2,534	63,360	63,360
2	1,010	25,251	88,656	1,012	25,295	88,656

In the case of loyalty, two factors are necessary to explain this dimension, indicating that not all the variables belong to the same construct. Table 13 analyzes the structure of the factors to verify this finding.

Table 13. Components Matrix - Student Loyalty

Nº	Indicator	Components	
		1	2
6.1	I would choose the UA again to pursue my studies	0,931	0,028
6.2	I would change the AU if I had the opportunity[1]	-0,015	0,998
6.3	The TD would increase my preference for studying at the University	0,887	-0,118
6.4	I would recommend the Autonomous University of Chile	0,938	0,045

Note: All refer to the Impact of the Digital Transformation of the University (TD) on the Loyalty of each of the aspects evaluated. (1) If I had the opportunity to study elsewhere, I would leave this University, even when I perceive that the Digital Transformation could be beneficial for me.

Most of the variables “load” on the first factor (three of four), indicating that they make up the same construct, while the variable I would change the UA if I had the opportunity (P6.2) is the only relevant one in the conformation of the second. factor.

The foregoing gives indications that the indicator P6.2 does not belong to this dimension but forms another construct by itself; for this reason, it will be eliminated from the confirmatory factor analysis and said analysis was repeated with the three remaining variables. Table 14 shows the explained variability.

Table 14. Total Explained Variance - Student Loyalty

Components	Initial eigenvalues			Rotation		
	Total	% variance	cumulative variance %	Total	% variance	cumulative variance %
1	2,535	84,491	84,491	2,535	84,491	84,491

In this new analysis it is observed that a single factor was necessary to explain Loyalty, managing to explain 84.5% of the total variability. This result confirms that all the variables are part of the same construct.

Next, Table 15 presents the structure of this factor.

Table 15. Components Matrix - Student Loyalty

Nº	Indicator	Component
		1
6.1	I would choose the UA again to pursue my studies	0,931
6.2	I would change the AU if I had the opportunity[1]	0,889
6.4	I would recommend the Autonomous University of Chile	0,937

Note: All refer to the Impact of the Digital Transformation of the University (TD) on the Loyalty of each of the aspects evaluated.

The variables selected to integrate this dimension have a similar importance in the conformation of this construct, charging positively on it. This finding confirms that all the variables are part of the Loyalty construct.

Confirmatory Factor Analysis

Theoretical Considerations

To validate the theoretical model referring to the technological transformation of the University, the Confirmatory Factor Analysis (CFA) was used, which aimed to find out if the theoretical model satisfactorily fits the data, thus achieving empirical validation.

Table 16 below shows the results of applying the Kolmogorov-Smirnov Normality test to the variables that make up the Student Satisfaction Index model, proposed by Turkyilmaz, Temizer, and Oztekin (2018).

Table 16. Kolmogorov-Smirnov Normality Test

Variable	Statistic.	gl	Sig.
*** Image of the University**			
Interest in meeting student requirements	0,143	313	,000
Continuous commitment to innovation	0,161	313	,000
Community valuation and recognition	0,248	313	,000
Personal and professional prestige	0,185	313	,000
Social environment of the University	0,192	313	,000
*** Student expectations**			
Access to academic and administrative history	0,243	313	,000
Ease of use of administrative processes	0,259	313	,000
Advice and personalized teaching	0,169	313	,000
Integration to work groups and research networks	0,187	313	,000
Access to online learning resources2	0,259	313	,000
Communication with teachers and administrative staff	0,190	313	,000
Ease of finding employment	0,187	313	,000
*** Expected quality**			
Improvement in academic performance	0,181	313	,000
Flexibility in the hours of administrative requests	0,221	313	,000

Efficiency and speed in administrative processes	0,212	313	,000
Integration to work groups and research networks	0,211	313	,000
Access to online learning resources	0,213	313	,000
Communication with teachers and administrative staff	0,201	313	,000
Ease of finding employment	0,187	313	,000
*** Expected value**			
Quality of Education (price/quality ratio)	0,160	313	,000
Quality of Services (price/quality ratio)	0,161	313	,000
Professional prestige when studying and graduating	0,164	313	,000
*** Student Satisfaction**			
Satisfaction with administrative processes	0,190	313	,000
Satisfaction with the teaching-learning process	0,162	313	,000
Satisfaction with access to information and services	0,182	313	,000
Satisfaction with communication with teachers	0,183	313	,000
Satisfaction with student expectations	0,170	313	,000
*** Student Loyalty**			
I would choose the UA again to pursue my studies	0,203	313	,000
I would change the AU if I had the opportunity	0,184	313	,000
I would recommend the Autonomous University of Chile	0,182	313	,000

As happens most of the time, in all the variables present in the model, the Kolmogorov-Smirnov test has a p-value less than 0.05 (p = 0.000). In this way, H0 is rejected, indicating that the variables do not have a normal distribution.

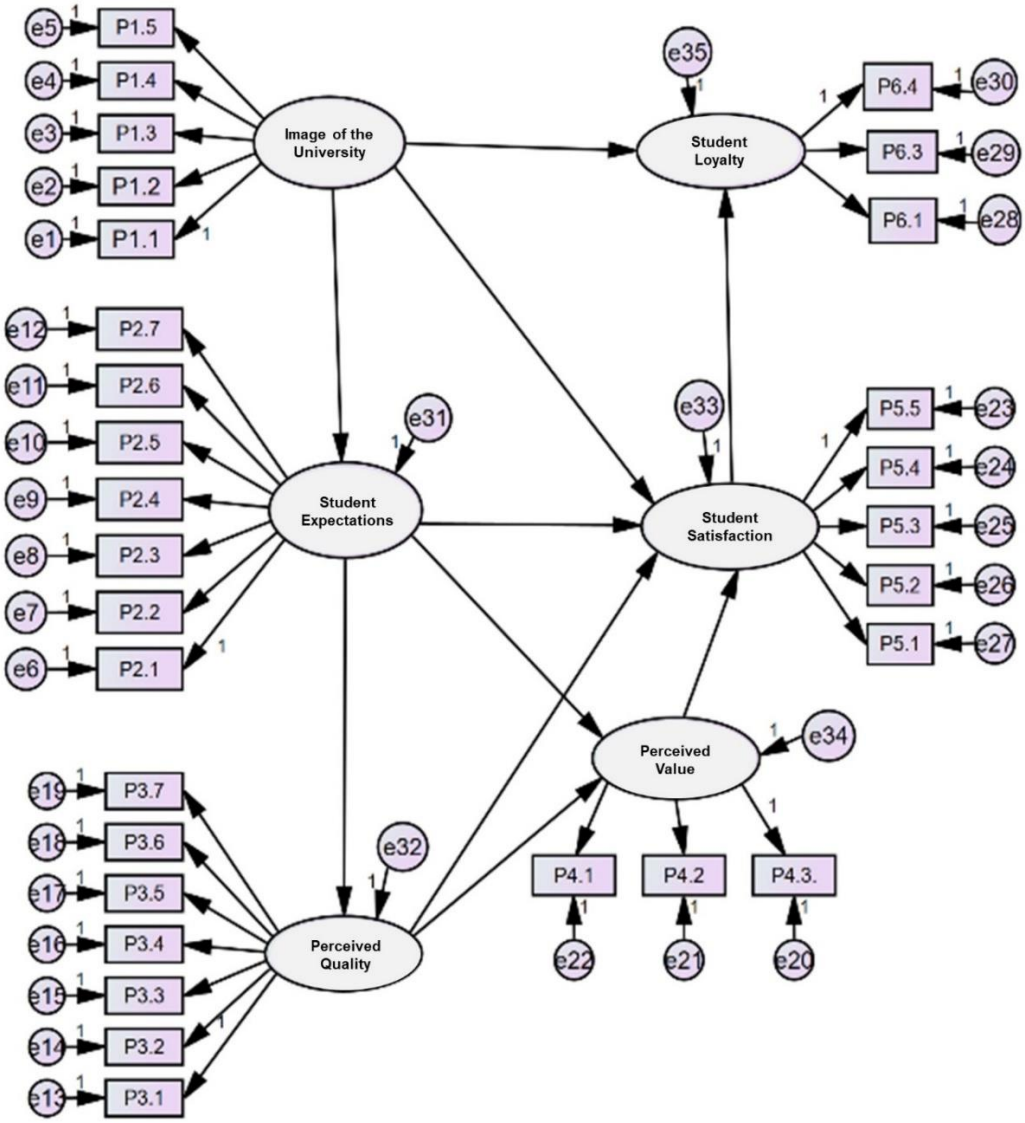
The multivariate normality of the observed variables is a requirement for the use of the CFA (Mulaik, 2010). In this case, this assumption is not met, so it is not recommended to use the Maximum Likelihood (ML) method, since it provides unbiased estimators.

Another assumption for the use of the CFA is that the nature of the variables must be continuous, while those used in this study are ordinal, for which reason the Unweighted Least Squares method (ULS) will be used.

Evaluation of Confirmatory Factor Analysis

Next, Figure 4 shows the causal relationship diagram (path diagram) created in the AMOS software as the start of the CFA.

Figure 4. Path diagram



To know the goodness of fit, the following indicators calculated by AMOS were analyzed.

Table 17. Fit Index

Index	Value
Normed Fit Index (NFI)	0,995
Goodness of Fit Index (GFI)	0,996
Adjusted Goodness of Fit Index (AGFI)	0,995
Root Mean Square Residual (RMR)	0,147

The Normed Fit Index (NFI) measures the proportion of the total variability explained by the proposed factorial model but considers the degrees of freedom of the proposed model and the null. This indicator is not sensitive to sample size. A value greater than 0.90 is considered acceptable. In the fit of the model found the NFI = 0.995, being higher than 0.90, indicating that the variability explained by the model (99.5%) is good.

The Goodness of Fit Index (GFI) provides guidance on whether the model should be adjusted. The closer it is to zero, the worse the fit. Values greater than 0.90 are good. The GFI = 0.996 (GFI > 0.90) indicates that we are in the presence of a good fit.

Related to the previous index, we find the Adjusted Goodness of Fit Index (AGFI), which corrects the tendency of the GFI to increase as the sample is larger, adjusting the value by the degrees of freedom. The acceptance criteria are the same: the values must be greater than 0.90. In this case the AGFI = 0.995; maintaining the criterion that the fit to the model is good.

Finally, the Root Mean Square Residual (RMR) is an index based on residuals. Measures the differences between the matrix of variances and covariances of the sample with that of the estimates of the model. This value must be close to zero to be acceptable. In the case of this research, the RMR = 0.147 (close to zero), so the model would be acceptable under the above criteria.

Considering all the indices of the goodness of fit to the model and the proportion of variance explained, it can be ensured that we are in the presence of a good fit of the model. Finally, we can conclude that the theoretical model of Satisfaction fits the data and is empirically validated by them.

Estimated model parameters.

According to Ruiz (2000) the equations that define the model will be, for the exogenous variables:

$x1 = \lambda 11 \xi 1 + \delta 1$

$x2 = \lambda 21 \xi 1 + \delta 2$

$x3 = \lambda 31 \xi 1 + \delta 3$

$x4 = \lambda 41 \xi 1 + \delta 4$

.

.

.

$xk = \lambda ks\ \xi s + \delta 4$

Being Xi are the observed variables (i= 1,2, 3,...) ξs corresponds to the latent variables (s = 1,2,3,...); δi are the measurement errors for each observed variable, $\lambda$is are the weights or structural coefficients of the i-th variable over the latent variable s.

And for the endogenous variables of the model:

$y1 = \lambda 11 \eta 1 + \varepsilon 1$

$y2 = \lambda 21\ \eta 1 + \varepsilon 2$

$y3 = \lambda 31\ \eta 1 + \varepsilon 3$

$y4 = \lambda 41\ \eta 1 + \varepsilon 4$

.

.

.

$yk = \lambda ks\ \eta 2 + \varepsilon\ k$

Below, in Table 18, the estimates of the model parameters are shown.

Table 18. Parameter Estimation

Variable	Est.	Est. error
- Image of the University		
Interest in meeting student requirements	1,000	1,971
Continuous commitment to innovation	0,930	1,734
Community valuation and recognition	0,862	1,425
Personal and professional prestige	0,872	1,510
Social environment of the University	0,951	0,941
- Student expectations		
Access to academic and administrative history	1,000	1,638
Ease of use of administrative processes	1,050	1,270
Advice and personalized teaching	1,031	1,583
Integration to work groups and research networks	0,988	1,143
Access to online learning resources2	0,964	1,450
Communication with teachers and administrative staff	1,076	1,105
Ease of finding employment	1,096	1,404
- Perceived quality		
Improvement in academic performance	1,000	1,534
Flexibility in the hours of administrative requests	0,976	1,325
Efficiency and speed in administrative processes	1,030	1,129
Integration to work groups and research networks	1,105	0,776
Access to online learning resources	1,071	0,750
Communication with teachers and administrative staff	1,068	1,133
Ease of finding employment	1,035	1,290
- Perceived value		
Quality of Education, price/quality ratio	0,924	1,184
Quality of Services, price/quality ratio	0,918	1,089
Professional prestige when studying and graduating	1,000	0,578
- Student Satisfaction		
Satisfaction with administrative processes	1,057	0,737
Satisfaction with the teaching-learning process	1,040	0,508
Satisfaction with Access to information and services	1,051	0,674
Satisfaction with Communication with teachers	1,070	1,200
Satisfaction with student expectations	1,000	0,953
- Student Loyalty		
I would choose the UA again to pursue my studies	1,080	1,225
I would change the AU if I had the opportunity	1,120	0,490
I would recommend the Autonomous University of Chile	1,000	1,288

The previous table contains the parameters to estimate the indicators, calculated by the CFA.

Analyzing the estimated parameters for each coefficient, we find that all of them are of significant magnitude (λ > 0.5), revealing that the indicators or variables have an important contribution in explaining the latent variable to which they belong.

Likewise, all the variables belonging to each dimension have similar magnitudes; that is, there are no major differences between them.

Table 19 shows the parameters to estimate the values of the Dimensions or latent variables of the model.

Table 19. Parameter Estimation

Variable	Est.	Est. error
- Student expectations		
Image of the University	0,795	
- Expected quality		
Student expectations	0,943	
- Expected value		
Student expectations	0,409	0,544
Expected quality	0,682	0,234
- Student Satisfaction		
Image of the University	0,288	
Expected quality	0,738	0,234
Expected value	0,343	1,369
Student expectations	-0,461	0,544
- Loyalty		
Image of the University	0,286	
Student Satisfaction	0,698	0,212

Although the model is validated, there is a mixture of high estimated coefficients (greater than or equal to 0.7) and other coefficients of lesser magnitude, which indicate that not all the latent variables or dimensions are important to explain the different relationships of the proposed model.

The Image has a high covariation with the Student Expectations (0.80); being able to interpret that the better the image of the university, the greater the expectations that the student has about it.

We also found a strong relationship between Student Expectations and Perceived Quality (0.943).

Regarding the perceived value, the model proposes two relationships, with the influence of perceived quality (0.68) being more relevant than that originated by the student's expectations (0.409). From the above, it could be said that, if you want to favorably impact Perceived Value, a greater effort should be made to improve perceived quality, rather than trying to influence student expectations.

Satisfaction is mainly impacted by Perceived Quality (0.74) and to a lesser extent by Perceived Value (0.34) and Image (0.29). It is also moderately affected by the Student's Expectations, but in the opposite direction (-0.461), indicating that the higher the set of expectations that the student has, the lower the level of satisfaction will be; although this also depends on other variables, as stated above.

Regarding Loyalty, the model proposes two relationships, the main one being the impact generated by Satisfaction on Loyalty (0.70); that is, the greater the satisfaction, the greater the propensity to remain as a student at the university and to recommend it. The Image of the University has a lower weight (0.29), acting as a "modulator" that, in the presence of a good level of satisfaction, a good image of the university would strengthen and improve the level of loyalty.

DISCUSSION

The Confirmatory Factor Analysis (EFA) confirms that all the variables or indicators used to measure the dimension or construct were well defined, being adequate, confirming that all of them conform to the construct to which they were assigned, having a similar importance in their conformation.

The sample data empirically validate the proposed theoretical model, where student satisfaction, from the perspective of digital transformation (TD) of the Autonomous University of Chile, is caused by the perceived quality, the perceived value, the student expectations, and the image of the University.

Likewise, the student satisfaction and the image of the university impact loyalty, the first dimension being the most relevant.

The variable that will have the greatest effect on satisfaction is the perceived quality, so the digital transformation of the University must generate important and tangible changes in all the processes involved.

Another sensitive aspect that must be considered is the management of the student's expectations regarding DT, since these influence satisfaction in a negative way; that is, the higher the expectations, the more difficult it will be to satisfy the student.

Additionally, it is shown that a requirement that cannot be dispensed with to achieve a good level of loyalty is maintaining high levels of satisfaction, beyond the image that the university may have.

Drawing from the acquired findings, and with the goal of further enriching the existing understanding of the effects of digital transformation within the university sphere, it is advised to pursue additional research. This research should delve into the correlation between students' perspectives and their levels of satisfaction and allegiance toward the university. Moreover, it should investigate how such allegiance could reverberate on the institution's brand equity and reputation. Currently, there are no existing theoretical models incorporating these variables.

Additionally, it is relevant to replicate this study while considering variations across disciplinary areas among the respondents. Analyzing these differences is crucial as students' profiles, emotional attachment to the institution, and career expectations may vary based on their disciplines. Such variations could also be linked to national-level educational and employment policies.

Finally, this research contributes to the literature on educational management, as it provides a knowledge base to understand the way in which the changes associated with the digital transformation of the University impact the emotional well-being and satisfaction of students. This is a fundamental factor in ensuring that technology investments are consistent with institutional values and are truly aimed at improving the educational experience, as well as achieving a significant impact on the reputation and prestige of the university.

For the Autonomous University of Chile this can represent a competitive advantage as it will be better positioned to effectively adapt to the changing demands and expectations of students, and to thrive in the current technological and educational environment.

On the other hand, the methodology used to relate the digital transformation model with the student satisfaction model can be applied in any university institution and can serve as support for future research based on empirical data on this object of study.

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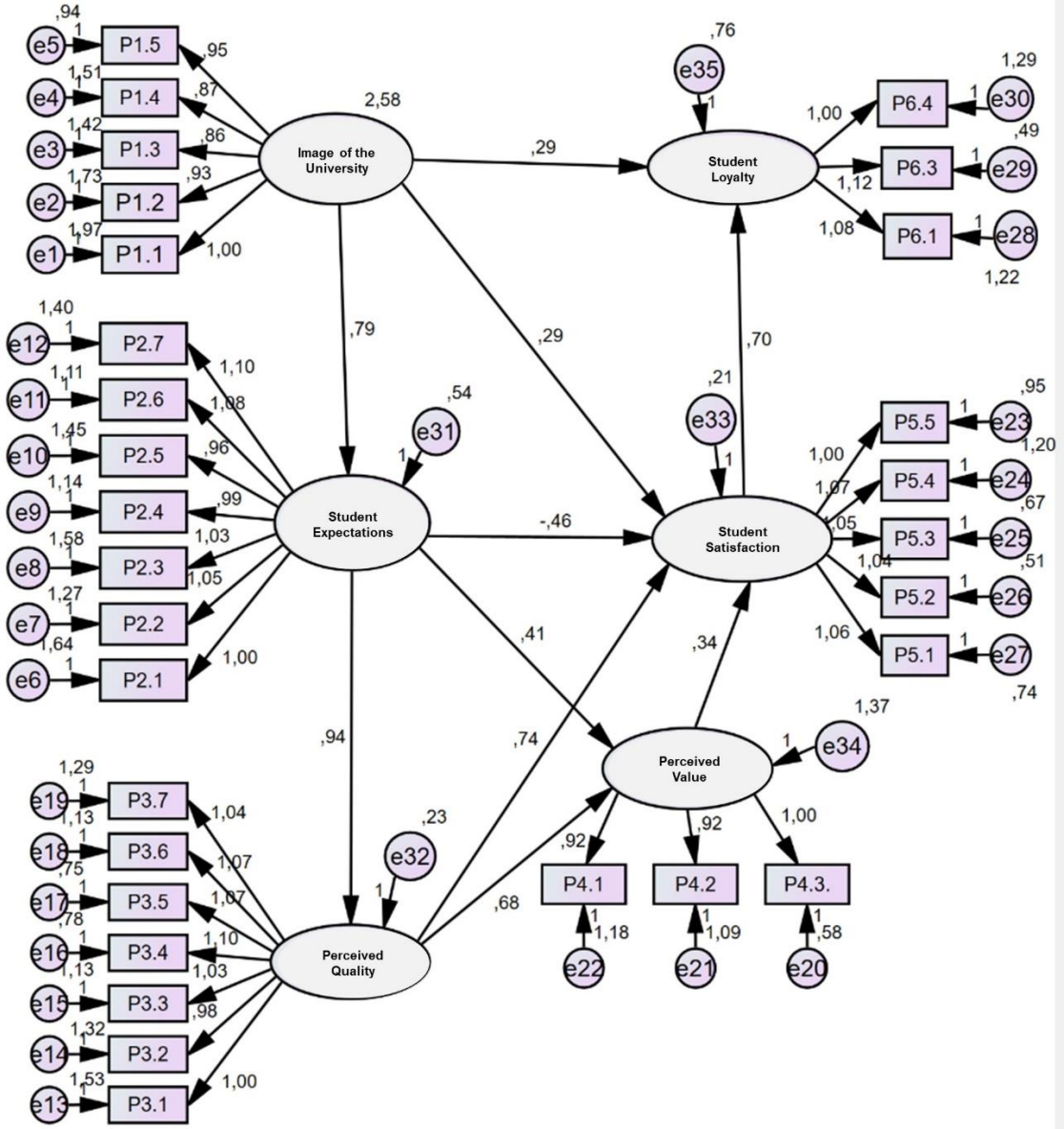
DECLARATION OF CONFLICTING INTERESTS

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

CRediT AUTHOR STATEMENT

Javier Manuel Muñoz Acuña: Conceptualization, Validation, Formal analysis, Investigation, Resources, Data curation, Writing—original draft preparation, Funding acquisition. Felipe Hernández-Perlines: Methodology, Supervision, Project administration. Manuel Alejandro Ibarra Cisneros: Methodology, Validation, Writing—review and editing, Visualization

APPENDIX: Diagram of causal relationships with parameters (AMOS)



* Note: Parameter estimates are standardized values.