Validació de la ciclina D3 com a reguladora clau de l'apoptosi de la cèl·lula beta pancreàtica induïda per estrès de reticle endoplasmàtic en la diabetis de tipus 1 (T1D)

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Propuesta de Modelo de Transformación Digital de la Universidad Autónoma de Chile y su Impacto en la Satisfacción del Estudiante

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ÍNDICE

RESUM

Els ràpids i profunds avenços en tecnologies digitals, juntament amb un nou marc d'exigències socials i laborals que s'imposa a nivell global, han impulsat canvis en la manera d'entendre i gestionar les organitzacions de tota mena els qui s'han vist obligades a transformar-se internament adaptar-se a les circumstàncies que prevalen a l'entorn amb l'interactuen. Per descomptat, les institucions educatives no han estat al marge d'aquest procés i, en el cas de les universitats, la urgència de transformació és encara més gran si es considera el seu rol com a formadors dels nous professionals que ingressen al mercat de treball, i com ens per excel·lència per a la generació del coneixement en les més diverses disciplines acadèmiques.

Moltes universitats s'han compromès amb una estratègia de transformació que respongui a la necessitat de mantenir-se competitives per complir la seva missió social, però en el cas xilè, i més concretament a la Universitat Autònoma de Xile, fins ara no s'han trobat estudis que analitzin els factors implícits en els processos de transformació que han de dur a terme.

Aquesta circumstància, juntament amb el reconeixement que cal actuar de manera peremptòria per modernitzar els seus processos acadèmics i administratius per tal d'adaptar-se als nous temps i elevar la satisfacció dels seus estudiants, ha motivat la realització d'aquesta recerca orientada a dissenyar un model de transformació digital d'acord amb les creences i les expectatives de l'estudiantat i del professorat d'aquesta Universitat.

Amb la realització prèvia d'una anàlisi bibliomètrica que reflecteix l'interès mundial creixent sobre aquest objecte d'estudi, i mitjançant la combinació de tècniques quantitatives i qualitatives es van recopilar dades que van permetre identificar nou dimensions i 54 indicadors que constitueixen la base del model de transformació digital de l'Universitat Autònoma de Xile. Aquest model va ser validat empíricament mitjançant un sistema d'equacions estructurals i s'ha demostrat, a més, el seu impacte en l'increment potencial de la satisfacció de l'estudiant i, consegüentment, en l'augment de la lleialtat cap a la institució.

Els productes de la recerca se sintetitzen en quatre articles científics que donen compte de la complexitat inherent a aquest objecte d'estudi, i que representen una aportació a la literatura en establir de manera clara les orientacions que impulsen l'èxit en l'obtenció, la utilització i la integració de les tecnologies disponibles, per elevar el grau de maduresa digital de la Universitat i mantenint el centre detenció en l'experiència de l'estudiant.

La tesi finalitza mostrant un conjunt de recomanacions, tant des de la perspectiva científica com no científica, orientades a aprofundir en el coneixement i les implicacions dels processos de transformació digital universitària

PARAULES CLAU

transformació digital, maduresa digital, educació superior, equacions estructurals

RESUMEN

Los rápidos y profundos avances en tecnologías digitales, junto con un nuevo marco de exigencias sociales y laborales que se impone a nivel global, han impulsado cambios en la forma de entender y gestionar las organizaciones de todo tipo quienes se han visto obligadas a transformarse internamente para adaptarse a las circunstancias que prevalecen en el entorno con el que interactúan. Por supuesto, las instituciones educativas no han estado al margen de este proceso y, en el caso de las universidades, la urgencia de transformación es aún mayor si se considera su rol como formadores de los nuevos profesionales que ingresan al mercado de trabajo, y como entes por excelencia para la generación del conocimiento en las más diversas disciplinas académicas.

Muchas universidades se han comprometido con una estrategia de transformación que responda a la necesidad de mantenerse competitivas para cumplir con su misión social, pero en el caso chileno, y más concretamente en la Universidad Autónoma de Chile, hasta la fecha no se han encontrado estudios que analicen los factores implícitos en los procesos de transformación que deben llevar a cabo.

Esta circunstancia, junto con el reconocimiento de que es necesario actuar de manera perentoria para modernizar sus procesos académicos y administrativos con el fin de adaptarse a los nuevos tiempos y elevar la satisfacción de sus estudiantes, ha motivado la realización de esta investigación orientada a diseñar un modelo de transformación digital acorde con las creencias y expectativas del estudiantado y del profesorado de esa Universidad.

Previa realización de un análisis bibliométrico que refleja el creciente interés mundial sobre este objeto de estudio, y mediante la combinación de técnicas cuantitativas y cualitativas se recopilaron datos que permitieron identificar nueve dimensiones y 54 indicadores que constituyen la base del modelo de transformación digital de la Universidad Autónoma de Chile. Dicho modelo fue validado empíricamente mediante un sistema de ecuaciones estructurales habiéndose demostrado, además, su impacto en el incremento potencial de la satisfacción del estudiante y, consecuentemente, en el aumento de su lealtad hacia la institución.

Los productos de la investigación se sintetizan en cuatro artículos científicos que dan cuenta de la complejidad inherente a este objeto de estudio, y que representan un aporte a la literatura al establecer de forma clara las orientaciones que impulsan el éxito en la obtención, utilización e integración de las tecnologías disponibles, a fin de elevar el grado de madurez digital de la Universidad y manteniendo el centro de atención en la experiencia del estudiante.

La tesis finaliza mostrando un conjunto de recomendaciones, tanto desde la perspectiva científica como no científica, orientadas a profundizar en el conocimiento e implicaciones de los procesos de transformación digital universitaria.

PALABRAS CLAVE

transformación digital, madurez digital, educación superior, ecuaciones estructurales

ABSTRACT

The rapid and profound advances in digital technologies, together with a new framework of social and labor demands that is imposed at a global level, have driven changes in the way of understanding and managing organizations of all types who have been forced to transform internally to adapt to the circumstances that prevail in the environment with which they interact. Of course, educational institutions have not been left out of this process and, in the case of universities, the urgency of transformation is even greater if one considers their role as trainers of new professionals entering the labor market, and as entities par excellence for the generation of knowledge in the most diverse academic disciplines.

Many universities have committed to a transformation strategy that responds to the need to remain competitive to fulfill their social mission, but in the Chilean case, and more specifically in the Autonomous University of Chile, to date no studies have been found that analyze the factors implicit in the transformation processes that they must carry out.

This circumstance, together with the recognition that it is necessary to act urgently to modernize its academic and administrative processes to adapt to new times and increase the satisfaction of its students, has motivated the carrying out of this research aimed at designing a digital transformation model in accordance with the beliefs and expectations of the students and faculty of that University.

After carrying out a bibliometric analysis that reflects the growing global interest in this object of study, and through the combination of quantitative and qualitative techniques, data was collected that allowed the identification of nine dimensions and 54 indicators that constitute the basis of the digital transformation model of the Autonomous University of Chile. This model was empirically validated through a system of structural equations, and its impact on the potential increase in student satisfaction and, consequently, in the increase in their loyalty to the institution has also been demonstrated.

The research products are synthesized in four scientific articles that account for the complexity inherent in this object of study, and that represent a contribution to the literature by clearly establishing the guidelines that drive success in obtaining, using, and

integrating of the available technologies, to raise the degree of digital maturity of the University and keeping the focus on the student experience.

The thesis ends by showing a set of recommendations, both from a scientific and non-scientific perspective, aimed at deepening the knowledge and implications of university digital transformation processes.

KEYWORDS

digital transformation, digital maturity, higher education, structural equations

1. INTRODUCCIÓN GENERAL

El surgimiento de las tecnologías digitales junto a la masificación de su uso representa un hito en la evolución socioeconómica de la humanidad. El paradigma de la era digital, cuyos inicios se remontan al año 2002 cuando la información acumulada en las herramientas tecnológicas superó el volumen de información analógica (Hilbert & López, 2011), produjo una brecha digital que cada vez es menor si se considera el contexto global (Hilbert, 2020). No obstante, este nuevo paradigma que comenzó con la proliferación de la comunicación y el almacenamiento de datos ha entrado en una nueva etapa en la que los algoritmos crean procesos automatizados que facilitan convertir la información en conocimiento procesable.

Esta evolución socioeconómica que deriva de los amplios desarrollos tecnológicos implica la adopción de un pensamiento estratégico orientado a la innovación, no solo en materia de productos y servicios, sino también en cuanto a las interacciones que se producen entre los usuarios y la tecnología, lo cual impacta en los procesos de creación de valor, en los aspectos financieros, en la forma de utilizar los recursos tecnológicos y en la propia estructura organizacional (Matt et al., 2015).

El valor que ofrecen las tecnologías de información en una sociedad basada en la economía del conocimiento ha sido estudiado desde dos aristas: la primera, en términos de la rentabilidad que pudiera obtenerse al implantar una infraestructura tecnológica en determinada organización, y la segunda, en torno a la perspectiva conceptual de la transformación digital, la cual implica un salto evolutivo para establecer relaciones entre la estrategia, la estructura y la tecnología a fin de responder asertivamente a los múltiples desafíos que plantea un entorno digital (Drechsler et al., 2020).

Sobre este particular, la complejidad de los aspectos que intervienen en la transformación digital ha sido argumentada por Rossman (2019) cuando señala la necesidad de desarrollar un conjunto de capacidades vinculadas a distintas dimensiones entre las que se incluye: el liderazgo, el mercado, las operaciones, las personas y las habilidades, la cultura, la gobernanza y la tecnología. Otros autores, como Mühlburger et al. (2019), relacionan la transformación digital con cuatro categorías de factores: valores organizacionales (cultura), capacidad de gestión, infraestructura organizacional y capacidades de la fuerza laboral; pero en todo caso ha sido documentado el enorme índice de fracaso en los proyectos de transformación digital, que alcanza la cifra del 87,5%

(Wade & Shan, 2020), motivado principalmente, según estos autores, por la formulación de expectativas poco realistas, errores de gobernanza y alcances limitados.

De este modo, con la transformación digital se presenta un nuevo escenario global, intensamente interconectado, que da importancia a las ideas, a la innovación y a las relaciones (Kelly, 1997), y a pesar de que durante las dos últimas décadas la transformación digital se ha convertido en una prioridad a nivel global (Schwab, 2016), todavía existen organizaciones que no logran integrar estas tecnologías en sus procesos culturales, estratégicos y de dirección (Linares, 2018), aun tras haberse argumentado que para poder ser líderes y enfocarse en las ventajas competitivas de alto impacto, las organizaciones apuestan por digitalizar todos sus procesos generadores de valor, ayudándose de las tecnologías de la información y la comunicación (TIC) que han dado forma a la denominada 'revolución digital' (Linares, 2018).

Es este carácter dinámico y evolutivo de la transformación digital el que conduce a comprender el concepto de madurez de dicho proceso, entendido como un marco integrado que permite medir la forma en que se desarrollan las capacidades claves que conduzcan al éxito en la nueva era digital (Lorenzo, 2016). Este proceso de maduración requiere cambios progresivos y mejoras incrementales orientadas a maximizar el valor de la tecnología en las organizaciones.

En el ámbito educativo, el impacto de este escenario tecnológico ha sido tan amplio que Facer y Selwyn (2021) llegaron a afirmar que las tecnologías digitales son una característica cada vez más destacada de la provisión y práctica de la educación contemporánea en todo el mundo, y son fundamentales para construir el imaginario social sobre el futuro de la educación. Lo anterior, aunado al hecho de que la importancia educativa de las tecnologías digitales se haya visto amplificada por la adopción masiva de recursos educativos digitales durante la pandemia por Covid-19, ha sembrado la esperanza, aun con cautela, acerca de la posibilidad de una profunda transformación de la educación.

Sin embargo, es sabido que la tecnología digital por sí sola no transforma la educación; de hecho, a pesar de la cada vez mayor visibilidad de los dispositivos digitales y los sistemas en línea, la esencia de los procesos educativos parece permanecer intacta ante la falta de cambios sustanciales que pudieran impactar favorablemente en la formación y en la experiencia del estudiante.

También se ha argumentado que aun cuando existen muchas explicaciones teóricas acerca de los posibles beneficios para el aprendizaje que surgen del uso de las tecnologías digitales, todavía existe poca evidencia sólida que valide esas afirmaciones y, en cualquier caso, los hallazgos obtenidos aún no son concluyentes. Por otro lado, la reducción de las desigualdades sociales mediante el empleo de recursos digitales en la educación no deja de ser una gran ambición, habiéndose señalado que el uso de la tecnología en la educación sigue estando sujeto a una serie de desigualdades persistentes y perniciosas que a menudo reproduce (Facer & Selwyn, 2021).

Ahora bien, en el contexto de la educación superior, que evidencia características diferentes a otros sectores industriales y de servicios (Catlin et al., 2015), no se han encontrado cifras que permitan dilucidar el índice de éxito en los proyectos de transformación digital, pero según Kirschner (2012, como se citó en Rodríguez-Abitia y Bribiesca-Correa, 2021) este proceso de transformación no ha estado a la par del ritmo de cambio que ha venido experimentando la sociedad; incluso, en ocasiones, ni siquiera ha obedecido a una estrategia universitaria sino que, por el contrario, ha sido una potestad discrecional de los docentes que no ha estado acompañada de ningún tipo de apoyo por parte de la universidad.

Además, se ha documentado que uno de los grandes desafíos que se le presenta a las universidades está representado por las diferencias generacionales entre los estudiantes 'nativos digitales' y el cuerpo docente (Balyer & Öz, 2018), así como por la persistencia de prácticas de liderazgo inadecuadas, cultura organizacional contraria al cambio, escasa planificación para la digitalización e indisponibilidad de los recursos financieros necesarios para ejecutar los planes (Rodríguez-Abitia & Bribiesca-Correa, 2021). Incluso se ha señalado que, si bien es cierto que el desarrollo de un conjunto específico de capacidades digitales conduce a una mayor madurez digital, para lo que existe toda una base conceptual y un modelo para evaluar la efectividad de los esfuerzos de transformación digital en las empresas (Castro et al., 2022), todavía no existe un marco de medición para la madurez digital en el trabajo académico (Rossmann, 2019).

En este escenario, si bien es cierto que la gestión del conocimiento es un punto estratégico para la transformación digital de las universidades (Ramírez-Montoya, 2020), dicha gestión no puede estar supeditada a la temporalidad de una crisis puntual o a la simple adquisición de plataformas tecnológicas para sustentar los procesos académicos, tal como

sucedió en el contexto de la pandemia por Covid-19, sino que implica la adopción de profundos cambios culturales acompañados de nuevos modelos de gestión, docencia e innovación en sus dimensiones organizacional, tecnológica y sociocultural (Castro et al., 2022).

En tal sentido, en el contexto de las instituciones de educación superior, la trasformación digital puede ser interpretada como un cambio profundo y acelerado de los procesos, las competencias y los modelos para aprovechar al máximo las oportunidades que brindan las tecnologías digitales (Demirkan et al., 2016). También ha sido entendida como un proceso de gestión que orienta la cultura, la estrategia, las metodologías y las capacidades de una organización a partir del uso de las tecnologías digitales (Crespo & Pariente, 2018), y como un proceso de cambio que puede ser disruptivo o incremental, y que comienza con la adopción y uso de tecnologías digitales para luego evolucionar hacia la transformación digital holística de la organización (Teichert, 2019).

Estos elementos de juicio apuntan a la necesidad de considerar que cualquier impacto que surja tras la introducción de las tecnologías digitales en los sistemas educativos, es específico de determinado contexto sociocultural, y está estrechamente relacionado con factores sociotécnicos que evidencian la multidimensionalidad del fenómeno educativo en la era digital. En consecuencia, cualquier intento de aprovechar las tecnologías digitales y generar mayor valor al estudiante a través de los procesos de enseñanza-aprendizaje y de los procesos económico-administrativos, debiera tomar en cuenta las características del sistema en el que se produce el hecho educativo.

Visto de este modo, la transformación digital exige la presencia de un modelo interdisciplinario y multidimensional que defina las bases y las premisas de cómo la organización se interrelaciona con su ecosistema para generar valor (Lorenzo, 2016), pero los desarrollos teóricos relativamente recientes en las prácticas de transformación digital dan muestras de ser genéricos, haciéndolos propicios para ser aplicados en varios sectores, pero ninguno de ellos ofrece un marco específico de acción para un determinado contexto académico.

Para el caso chileno, por ejemplo, donde en el año 2019 existían 61 universidades que concentraban una matrícula de 749 mil alumnos (Kerrigan, 2020) distribuidos en carreras técnicas y profesionales además de programas de posgrado y postítulo, aunque las instituciones de educación superior de Chile se esforzaron para identificar y anticipar las

habilidades digitales demandadas en el mercado laboral, no se han encontrado estudios que reflejen las dimensiones que fueron consideradas para desarrollar los procesos de transformación digital holística en el ámbito interno de tales universidades, y menos aún para medir la evolución de dichos procesos en términos de madurez digital.

Este vacío en la literatura ha motivado la realización de un estudio orientado, en primer lugar, a precisar cómo ha venido creciendo el interés científico mundial en abordar la problemática de la transformación digital en las instituciones de educación superior y, en segundo lugar, a determinar el impacto de esa transformación en la satisfacción de los estudiantes. Para ello y tomando como contexto de estudio el caso específico de la Universidad Autónoma de Chile, se diseñó un modelo teórico de transformación digital para esa Universidad a partir de las dimensiones y factores que tanto la población estudiantil como los expertos en el área consideraban fundamentales. Este modelo, previamente validado mediante un sistema de ecuaciones estructurales, fue sometido a nuevos análisis para determinar las relaciones de causalidad que existían entre los resultados que se esperaban obtener mediante la transformación digital de la Universidad y la satisfacción de los estudiantes.

En virtud de lo anterior, la investigación estuvo orientada a responder las siguientes interrogantes:

1. ¿Cómo ha evolucionado el interés científico mundial sobre la transformación digital en las instituciones de educación superior durante el periodo 2014-2022?
2. ¿Cuál es el modelo teórico del proceso de transformación digital que puede ser implantado en la Universidad Autónoma de Chile para responder a las nuevas demandas del sistema educativo y medir el grado de madurez digital alcanzado por la Universidad en sus distintas dimensiones?
3. ¿El modelo de transformación digital diseñado para la Universidad Autónoma de Chile es consistente desde la perspectiva teórica, y fiable desde el punto de vista de su utilidad para tomar decisiones informadas, hacer predicciones precisas y verificar hipótesis subyacentes?
4. ¿Cuál será el impacto potencial de la transformación digital de la Universidad Autónoma de Chile en la satisfacción de los estudiantes y en su lealtad hacia la institución?

2. OBJETIVOS

2.1 Objetivo general

Dada la importancia de aprovechar los beneficios que ofrecen las tecnologías de información en una sociedad basada en la economía del conocimiento, con el fin de asegurar la satisfacción de los estudiantes de educación superior en el contexto chileno, el propósito de la investigación fue diseñar un modelo específico de transformación digital para la Universidad Autónoma de Chile que contribuya a aumentar la calidad y el valor que perciben los estudiantes, y a asegurar la satisfacción de sus requerimientos en cuanto al cumplimiento de sus expectativas académicas y profesionales.

2.2 Objetivos específicos

A la luz del objetivo general y de las interrogantes que guiaron la investigación, los objetivos específicos fueron formulados del siguiente modo:

1. Describir el grado de desarrollo de la investigación en transformación digital en instituciones de educación superior en los últimos nueve años (2014-2022) a nivel mundial.
2. Diseñar un Modelo de Transformación Digital para ser implantado en la Universidad Autónoma de Chile.
3. Validar el Modelo de Transformación Digital de la Universidad Autónoma de Chile, mediante un sistema de ecuaciones estructurales.
4. Determinar el impacto de la transformación digital de la Universidad Autónoma de Chile en la satisfacción y lealtad de los estudiantes hacia la institución, mediante el análisis de las relaciones de causalidad entre el modelo propuesto de transformación digital y el modelo de Índice de Satisfacción del Estudiante, propuesto por Turkyilmaz, et al. (2018).

3. METODOLOGÍA

Los métodos utilizados para el desarrollo de la investigación variaron en función de los propósitos planteados para cada uno de los objetivos específicos, tal como se describe a continuación.

3.1 Primer objetivo específico

Para el desarrollo del primer objetivo específico se realizó un metaanálisis de las publicaciones científicas que utilizaban base de citación homogénea, evitando la imposibilidad de comparar bases de datos de indexación que utilizan diferentes bases de cálculo para determinar los factores de impacto y cuartiles de las revistas (Bakkalbasi et al., 2006; Chadegani et al., 2013; Falagas et al., 2008; Harzing & Alakangas, 2016; Mongeon & Paul-Hus, 2016); colección principal de Web of Science (WoS) (Clarivate, 2022), selección de documentos publicados en revistas indexadas por WoS en Emerging Sources Citation Index (ESCI), Science Citation Index Expanded (SCIE) y Social Science Citation Index (SSCI), Conference Proceedings Citation Index - Science (CPCI-S); Conference Proceedings Citation Index - Social Science & Humanities (CPCI-SSH), a partir de un vector de búsqueda sobre Transformación Digital en la Educación Superior TS=(Digital NEAR/0 transform) AND (Higher NEAR/0 education), sin parámetros temporales restringidos, realizándose la extracción el 15 de octubre de 2022. Se incluyeron los siguientes tipos de documentos: artículos, actas de reuniones, reseñas, material editorial, reseñas de libros y cartas.

El análisis bibliométrico fue realizado sobre un conjunto de unidades documentales (artículos y otros documentos científicos) relacionados con la Transformación Digital en la Educación Superior, revisando las leyes bibliométricas fundamentales que a continuación se indican:

1. Crecimiento exponencial de la ciencia o Ley de Price, a través del grado de ajuste exponencial del crecimiento anual de las publicaciones, como medida de un fuerte interés de la comunidad científica por desarrollar estudios sobre DT2HE, conformando una masa crítica de investigadores que desarrollan este tema de conocimiento (Dobrov et al., 1979; Price, 1976).

2. Concentración de publicaciones en revistas o Ley de Bradford, distribuyendo las revistas en tercios según el número decreciente de documentos publicados en ellas, estableciéndose como núcleo de revistas con mayor concentración las que abarquen al menos el 33% del total de publicaciones (Bulick, 1978; Morse & Leimkuhler, 1979).
3. Concentración de publicaciones en autores o Ley de Lotka, reconociendo que, en cualquier campo del conocimiento, la mayoría de los artículos provienen de una pequeña proporción de autores prolíficos, quienes, al ser identificados, pueden ser estudiados aisladamente (Coile, 1977), información que ha sido complementada con WoS Author (Clarivate, 2022).
4. Concentración de citas en artículos o índice de Hirsch (índice h), considerando así los "n" artículos citados al menos "n" veces o más; concentración que se extiende por transitividad a sus autores (índice h de autor, con base en sus publicaciones) (Hirsch, 2005).
5. Concentración de palabras clave o Ley de Zipf, destacando las palabras clave más utilizadas en el conjunto de artículos (Zipf, 1932).

Finalmente, se utilizó el software VOSviewer para realizar el procesamiento y visualización del conjunto de datos, así como la co-ocurrencia, realizando un análisis de fragmentación con salidas de visualización agrupadas (Araya-Castillo et al., 2022; Perianes-Rodriguez et al., 2016; Waltman et al., 2010). De esta manera se pudo hacer un análisis descriptivo del grado de desarrollo de la investigación científica sobre transformación digital en instituciones de educación superior durante los últimos nueve años (2014-2022) a nivel mundial.

3.2 Segundo objetivo específico

Para la consecución del segundo objetivo específico y con el fin de diseñar un Modelo de Transformación Digital para el caso de la Universidad Autónoma de Chile se realizó una investigación desde un enfoque mixto (cuantitativo – cualitativo), de nivel exploratorio, transversal (Malhotra, 2004) y aplicando las técnicas de recogida de datos que corresponden al diseño de campo. Luego de efectuar una revisión de la literatura se creó un modelo inicial compuesto por 11 dimensiones preliminares y 54 factores subyacentes;

posteriormente, se evaluó su relevancia y aplicabilidad práctica mediante un cuestionario dirigido a 97 estudiantes de la Universidad Autónoma de Chile (Anexo I) y la realización de entrevistas semiestructuradas a ocho expertos (Anexo II), que permitían cierta flexibilidad para descubrir información valiosa para los fines que se perseguían. Para la selección de la muestra se utilizaron técnicas no probabilísticas (muestreo por conveniencia) basadas en los planteamientos de Denzin y Lincoln (2000), quedando constituida de la forma que se indica en la Tabla 1:

Tabla 1 *Composición de la muestra*

Descripción de la muestra	Tamaño de la muestra	Distribución por género	Distribución por área de estudio	Técnica (instrumento)
Estudiantes de carreras de grado en la Universidad Autónoma de Chile	97	55 hombres (56,7%) 42 mujeres (43,3%)	Administración y Economía (73,2%) Ingeniería (24,7%) Otras carreras (2,1%)	Encuesta (cuestionario)
Expertos	8	6 hombres (75%) 2 mujeres (25%)	-	Entrevistas en profundidad

El cuestionario aplicado a los estudiantes fue sometido previamente a validación mediante la técnica de juicio de expertos con la participación de 40 evaluadores. A cada experto consultado se le proporcionó el cuestionario en el que se indicaban las dimensiones y factores preliminares vinculados al constructo, junto con los criterios de valoración, para que indicasen el grado de importancia de cada ítem del instrumento. Para ello disponían de tres opciones de respuesta: ‘esencial’, ‘útil pero no esencial’ o ‘no esencial’. Con esos datos y siguiendo el modelo de Lawshe (1975) se determinó la Razón de Validez de Contenido (CVR y CVR´) para cada uno de los ítems y se calculó la Validez Global de Contenido (CVI) para todo el instrumento (Anexo III).

Como resultado de este proceso se determinó que las 11 dimensiones inicialmente propuestas fueron validadas al obtener una validez global de 0.661. En lo referente a los factores implícitos en las dimensiones, solo uno de ellos no pudo ser validado al obtener una razón de validez ajustada de 0,375. La validez de contenido global del instrumento fue de 0,714.

En la Tabla 2 se muestran las fórmulas utilizadas para determinar la razón de validez de contenido para cada ítem (CVR); razón de validez de contenido ajustado (CVR’) e índice de validez de contenido (CVI).

Tabla 2 *Fórmulas utilizadas para determinar la validez de contenido del instrumento (modelo de Lawshe)*

Cálculo de la Razón de Validez de Contenido para cada ítem	Cálculo de la Razón de Validez de Contenido para cada ítem (modelo de Lawshe ajustado)	Cálculo de la Validez Global del Instrumento
$CVR = \frac{n_e - \frac{N}{2}}{\frac{N}{2}}$	$CVR' = \frac{CVR + 1}{2}$	$CVI = \frac{\sum_{i=1}^{M} CVRi}{M}$
Donde: n_e = número de expertos que consideran que el ítem como "esencial" N = Número total de expertos que respondieron el instrumento	Donde: *CVR* = Razón de Validez de Contenido para cada ítem	Donde: CVR_i = Razón de Validez de Contenido de los ítems aceptados *M* = Total de ítems aceptados en el instrumento

Una vez validado el cuestionario, se envió por Google Forms a los 97 estudiantes que participaron en el estudio. Este cuestionario se dividió en tres secciones:

- La primera sección estaba destinada a recoger los datos generales del encuestado (género, nivel académico y área disciplinar)
- En la segunda sección se les mostraban las 11 dimensiones inicialmente propuestas, con sus respectivas definiciones, para que señalaran mediante una escala de Likert con cinco opciones de respuesta, el grado de importancia que le atribuían a cada dimensión. Las opciones de respuesta eran: Sin importancia; Poco importante; Neutral; Importante; y Muy importante, que posteriormente fueron traducidas a valores cuantitativos, siendo (1) el que correspondía a la opción "Sin importancia" y (5) a la opción "Muy importante".
- En la tercera sección se les mostraba un conjunto de factores relacionados con cada una de las dimensiones enunciadas en la sección anterior, con el fin de que indicaran su valoración sobre el grado de importancia de cada factor para gestionar la transformación digital de la Universidad Autónoma de Chile. Para ello utilizaron una escala de Likert con las mismas opciones de respuesta y manteniendo el mismo sistema de conversión a datos cuantitativos para su procesamiento mediante técnicas estadísticas.

En relación con las técnicas cualitativas de recogida de información, se realizaron ocho entrevistas semiestructuradas a directivos de la Universidad Autónoma de Chile y expertos en transformación digital, quienes aportaron sus conocimientos, reflexiones y valoraciones sobre el objeto de estudio. Las entrevistas fueron grabadas, transcritas y sometidas a un proceso de codificación en el que se asignaron categorías conceptuales a los segmentos de información que eran de interés para alcanzar los objetivos del estudio. Posteriormente, mediante la elaboración de una matriz de intensidad (Anexo IV) que facilitó la interpretación de las informaciones obtenidas, se crearon nuevas relaciones y se identificaron pautas significativas entre dimensiones y factores que permitieron elaborar el modelo teórico preliminar del proceso de transformación digital de la Universidad Autónoma de Chile, en el cual se integró la información aportada tanto por los estudiantes que respondieron el cuestionario como por los expertos entrevistados.

De este modo, las 11 dimensiones inicialmente propuestas se redujeron a nueve, las cuales fueron distribuidas en tres fases de acuerdo con la naturaleza de los factores que estaban implícitos en cada una de ellas. Estas nueve dimensiones conformaron el modelo teórico preliminar del proceso de transformación digital de la Universidad Autónoma de Chile. En la Tabla 3 se hace una comparación entre las dimensiones inicialmente propuestas y las dimensiones que conforman el modelo que posteriormente sería sometido a validación empírica mediante el modelado de ecuaciones estructurales (tercer objetivo específico)

Tabla 3. *Comparación entre las dimensiones iniciales propuestas y las dimensiones finales del modelo de transformación digital de la Universidad Autónoma de Chile*

Dimensiones iniciales propuestas	Dimensiones finales (por fases del proceso de TD)
1. Marco Estratégico Institucional enfocado a la transformación digital 2. Cultura Digital 3. Organización y Estructura 4. Capacidades críticas y recursos claves 5. Valor del ciclo de vida del estudiante 6. Ecosistema (socios y aliados estratégicos que debiera tener una Universidad) 7. Enseñanza flexible y personalizada 8. Puntos de contacto con el estudiante 9. Redes sociales e investigación de perfiles 10. Procesos de transformación de la docencia para la educación superior 11. Inversión en TI	Fase 1: Disponibilidad de recursos digitales 1. Estrategia y cultura 2. Recursos financieros 3. Base tecnológica Fase 2: Utilización de recursos digitales 4. Enfoque en el estudiante 5. Procesos de enseñanza-aprendizaje 6. Procesos académico-administrativos Fase 3: Integración de plataformas tecnológicas 7. Gobernanza informática 8. Competencias y capacidades 9. Gestión de procesos internos

3.3 Tercer objetivo específico

Para el tercer objetivo específico, relacionado con la validación del modelo teórico preliminar de transformación digital de la Universidad Autónoma de Chile, el proceso metodológico se llevó a cabo, inicialmente, mediante la comprobación de la validez de los constructos a través de: (1) la validación convergente, que permitió evaluar hasta qué punto los ítems seleccionados eran representativos para definir las variables latentes del modelo; (2) la validación discriminante, que sirvió para verificar que los indicadores asociados a una variable latente no estuvieran relacionados con otros constructos, y (3) el análisis factorial, a fin de determinar cuánto contribuía cada factor a definir el constructo con el que estaba asociado. Posteriormente se aplicó el modelo estructural evaluando la bondad del ajuste a partir de las medidas de ajuste absoluto, de ajuste incremental y de parsimonia, y validando luego las relaciones entre las 9 variables y los 54 indicadores que conformaban el modelo de transformación digital.

La validación del modelo preliminar de transformación digital de la Universidad Autónoma de Chile fue realizada mediante la técnica de modelado de ecuaciones estructurales (SEM, por sus siglas en inglés), la cual es comúnmente utilizada en estudios correlacionales en los que solamente se observa la magnitud de las variables que no son manipuladas por el investigador. Estos modelos de ecuaciones estructurales constan de dos partes fundamentales: (1) el modelo de medida, que contiene la manera en que cada constructo latente se encuentra medido mediante sus indicadores observables, los errores que afectan a las mediciones y las relaciones que se esperan encontrar entre los constructos cuando estos están relacionados entre sí; y (2) el modelo de relaciones estructurales, el cual contiene los efectos y relaciones entre los constructos (Ruiz et al., 2010).

Para el estudio se requirió la realización del análisis factorial el cual es considerado como la técnica por excelencia para la validación de constructos teóricos (Pérez-Gil et al., 2000). Este es un modelo estadístico que representa las relaciones entre un conjunto de variables o ítems que pueden explicarse a partir de una serie de variables no observables (latentes) denominadas factores, los cuales, en número, son sustancialmente menores que el de las variables observables (Ferrando & Anguiano-Carrasco, 2010).

Conceptualmente, los análisis factoriales poseen dos modalidades: el Análisis Factorial Exploratorio (AFE, por sus siglas en inglés) y el Análisis Factorial Confirmatorio (AFC), cuya diferencia fundamental radica en el hecho de que el AFE es una técnica basada en los datos que intenta descubrir la estructura subyacente que estos poseen mediante la búsqueda de patrones de relación entre los indicadores, mientras que el AFC se conduce principalmente por teorías sustantivas y por expectativas, por lo que la contrastación de las hipótesis estructurales que derivan de la teoría será la que determinará la validez del constructo.

De manera general, el Análisis Factorial Exploratorio se refiere a un conjunto de métodos estadísticos multivariados de interdependencia que tienen el propósito de identificar una estructura de factores subyacentes a un amplio conjunto de datos (Pérez & Medrano, 2010). Cada uno de estos factores agrupa a los ítems interrelacionados que, al mismo tiempo, son relativamente independientes de los restantes conjuntos de ítems. Esta interrelación entre ítems se debe a que tales variables poseen algo en común y algo que las diferencia, por lo que su varianza total es debida, tanto a factores que comparte con las otras variables (comunalidad) como a factores que son propios o específicos de dicha variable (especificidad). De manera concreta, el análisis factorial exploratorio (AFE) se realizó con el fin de determinar las estructuras de los factores subyacentes; es decir, para identificar las variables observadas que estaban asociadas con cada variable latente. Para ello utilizó el paquete estadístico IBM SPSS.

Por su parte, con el Análisis Factorial Confirmatorio se pretendía estimar la correlación entre las variables latentes y su asociación con los ítems del modelo sujeto a validación (Manzano, 2018); es decir, evaluar si las variables latentes podían ser explicadas por un número más pequeño de factores subyacentes. De este modo, la estructura preliminar del modelo podía ser confirmada o rechazada mediante la comparación de los resultados obtenidos a partir de los datos observados. En esta fase se utilizó la extensión AMOS, v.23 del paquete estadístico SPSS.

Las pruebas estadísticas aplicadas como paso previo al análisis factorial fueron: la prueba de Kaiser-Meyer-Olkin (KMO), y la prueba de esfericidad de Bartlett. La prueba KMO permitió medir la idoneidad de los datos para el análisis factorial en términos de la adecuación del muestreo para cada variable en el modelo. El valor resultante reflejaba la proporción de varianza en las variables que podían ser causadas por factores subyacentes.

Un valor menor de 0,5 indicaba que los resultados del análisis factorial quizás no fueran de gran utilidad (IBM, 2023).

Por su parte, la prueba de esfericidad de Bartlett permitió comparar la matriz de correlaciones con la matriz de identidad, de manera tal que se lograra comprobar si había variables redundantes que se pudieran resumir con algunos factores. Los valores pequeños del nivel de significación (menores que 0,05) indicaban que el análisis factorial podía ser útil con los datos disponibles (IBM, 2023).

Para determinar el número de factores a extraer a fin de lograr la estructura factorial más parsimoniosa se utilizaron gráficas de sedimentación *(Scree Plot),* en la que se reflejaban los factores que explicaban la mayor parte de la variabilidad total de los datos.

3.4 Cuarto objetivo específico

Finalmente, para lograr el propósito indicado en el cuarto objetivo específico y encontrar las relaciones de causalidad entre la transformación digital de la Universidad Autónoma de Chile y la satisfacción de los estudiantes, también se aplicó la técnica de modelado de ecuaciones estructurales mediante la realización del análisis factorial en sus dos modalidades: el Análisis Factorial Exploratorio (AFE) y el Análisis Factorial Confirmatorio (AFC).

El Análisis Factorial Exploratorio (AFE) tuvo el propósito de comprobar la estructura teórica de los datos que pudieran explicar el impacto de la transformación digital de la Universidad Autónoma de Chile en la satisfacción del estudiante, habiéndose utilizado para ello el modelo de Índice de Satisfacción de los Estudiantes, propuesto por Turkyilmaz et al., (2018), el cual está basado en la estructura del modelo del Índice de Satisfacción del Cliente Europeo.

Al respecto, teniendo definidas a priori las dimensiones de dicho modelo (imagen, expectativas del estudiante, calidad percibida, valor percibido, satisfacción y lealtad), el Análisis Factorial Exploratorio tuvo la finalidad de validar estadísticamente cada dimensión, verificando la consistencia interna de cada constructo. Para ello, cada variable o indicador fue medido a través de un cuestionario dirigido a los estudiantes, el cual estaba estructurado en seis secciones y 31 preguntas para ser respondidas utilizando una escala semántica de diez niveles mediante la que se deseaba conocer qué tan de acuerdo estaba

el estudiante con cada uno de los aspectos planteados (Anexo V). Dicho cuestionario fue previamente sometido a un proceso de validación por juicio de expertos (Anexo VI), obteniéndose un coeficiente ajustado de razón de validez de contenido (CVR) de 0,823 (Anexo VII).

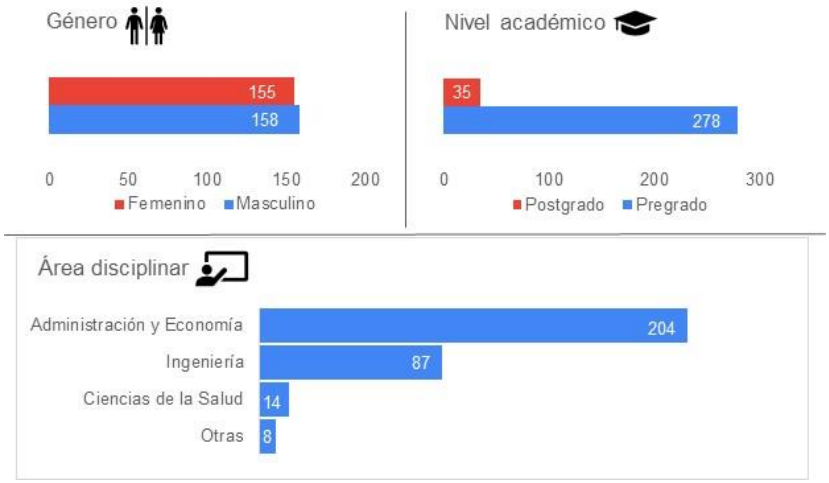
La amplitud de la escala del cuestionario iba desde el valor 1, que significaba el menor grado de acuerdo ("en total desacuerdo"), hasta el valor 10: el mayor nivel de acuerdo con la frase o aspecto evaluado ("totalmente de acuerdo"). Solo en la sección cinco, donde se exploraba la *Satisfacción*, el significado de la escala era distinto, ya que el valor 1 significaba *Totalmente Insatisfecho* y el valor 10: *Totalmente Satisfecho*.

Para este análisis se escogió el método factorial: *Análisis de Componentes Principales* debido a que las variables o indicadores fueron medidas a través de una escala ordinal de diez niveles; siendo el método de rotación utilizado el "*Varimax*" el cual, rota los ejes de los factores de forma ortogonal, haciendo que tengan un ángulo de 90º entre ellos, lo cual da facilidad para interpretar los resultados.

Previo al Análisis Factorial Exploratorio se exploró si se cumplían las condiciones para su aplicación, utilizando para ello la prueba de *Kaise-Meyer-Olhin* (KMO) y el *Test de esfericidad de Bartlett*, del mismo modo que fue descrito en la sección 3.3

Para calcular el tamaño mínimo de la muestra requerida para realizar el Análisis Factorial Confirmatorio, se tomaron en consideración las indicaciones de Thompson (2004) quien recomienda que el tamaño de la muestra debe ser calculado en función del número de ítems o variables a razón de 10 a 20 casos por cada uno de ellos. Por consiguiente y al verificar que otros autores señalan que la muestra no debiera ser menor de 200 casos (Lloret-Segura et al., 2014), el tamaño de la muestra fue de 313 casos, indicando, en principio, que era adecuado para aplicar el AFC. En la Fig. 1 se ilustra la distribución de la muestra por género, nivel académico y área disciplinar a la que pertenecen los estudiantes que participaron en el estudio.

Figura 1. *Distribución de la muestra por género, nivel académico y área disciplinar*



De igual modo, todas las dimensiones estaban conformadas por nueve variables o indicadores, siendo superior a los tres indicadores que se considera como el mínimo requerido para este tipo de análisis (Batista-Foget & Coenders, 2000).

Dado que otro requerimiento para poder utilizar este modelo era el cumplimiento del supuesto de normalidad multivariante, para su comprobación se utilizó la prueba de normalidad de *Kolmogorov-Smirnov*. Esta prueba estadística permitió medir el grado de concordancia que existe entre la distribución de un conjunto de datos y una distribución teórica específica, y parte de la hipótesis nula (H0) de que la variable sigue una distribución normal, $X \sim N(\mu, \sigma 2)$. Para un nivel de significación $\alpha = 0{,}05$ si el p-valor asociado a la prueba es mayor a 0,05 se concluye que la variable se comporta como una distribución normal.

4. PUBLICACIONES E ÍNDICES DE CALIDAD

Publicación 1

Autores	Muñoz Acuña, Javier Manuel; Hernández-Perlines, Felipe; Vega-Muñoz, Alejandro; Salazar-Sepúlveda, Guido; Vinueza-Martínez, Jorge.
Título	Digital Transformation in Higher Education Institutions: Bibliometric Analysis
Revista	*International Journal of Innovation and Learning*
Estado	En revisión. Publicado como preprint en ResearchSquare (14/07/2023) DOI: https://doi.org/10.21203/rs.3.rs-3129316/v1

Índice de calidad de la revista: Scimago Journal Rank 2022: Q3 en Educación

Publicación 2

Autores	Muñoz Acuña, Javier Manuel; Hernández-Perlines, Felipe; Ibarra Cisneros, Manuel Alejandro
Título	Digital transformation model for universities: a preliminary proposal
Revista	*International Journal of Education and Practice*
Estado	Aceptado (Anexo VIII)
Año	2023
Índice de calidad de la revista:	Scimago Journal Rank 2022: Q3 en Educación

Publicación 3

Autores	Muñoz Acuña, Javier Manuel; Hernández-Perlines, Felipe; Ibarra Cisneros, Manuel Alejandro
Título	Validation of the digital transformation model of the Autonomous University of Chile
Revista	*International Journal of Emerging Technologies in Learning*
Estado	Aceptado (Anexo IX)
Índice de calidad de la revista:	Scimago Journal Rank 2022: Q2 en Educación

Publicación 4

Autores	Muñoz Acuña, Javier Manuel; Hernández-Perlines, Felipe; Ibarra Cisneros, Manuel Alejandro
Título	Impact of university digital transformation on the satisfaction of students at the Autonomous University of Chile
Revista	*Education Sciences*
Estado	En revisión
Índice de calidad de la revista:	Scimago Journal Rank 2022: Q1 en Educación

5. TRANSCRIPCIÓN DE LOS ARTÍCULOS

En esta sección se presentan los cuatro artículos que conforman la tesis, en el idioma y formato con el cual fueron enviados a las respectivas revistas.

Artículo 1: Digital Transformation in Higher Education Institutions: Bibliometric Analysis

Artículo 2: Digital transformation model for universities: a preliminary proposal

Artículo 3: Validation of the digital transformation model of the Autonomous University of Chile

Artículo 4: Impact of university digital transformation on the satisfaction of students at the Autonomous University of Chile

ARTÍCULO 1

Digital Transformation in Higher Education Institutions: Bibliometric Analysis

Revista: International Journal of Innovation and Learning

Digital Transformation in Higher Education Institutions: Bibliometric Analysis

Abstract: This article shows the results of a bibliometric analysis of the advances in digital transformation in higher education institutions worldwide. This was done using a search vector without restrictions in terms of time parameters, obtaining a total of 384 records between 2014 and 2022. The scientific production per year was analyzed (Price's Law); concentration of publications by journals (Bradford Law); concentration of publications by authors (Lotka's Law); concentration of citations per article (Hirsch Index) and concentration of the most prominent keywords related to digital transformation (Zipf's Law). Regarding the results, we have observed during the last nine years an exponential increase in scientific production on this subject of study that is being led by Spain, Russia, and Germany. Two prolific authors were identified, as well as the three main research orientations that emphasize the digital transformation process, its effects on students and the modernization of higher education.

Keywords: digital transformation; higher education; bibliometric analysis; Price's law; Bradford's law; Lotka's Law; Zipf's Law; Hirsch index

1 Introduction

The irruption of covid-19 accelerated the steps for the digital revolution that was already underway, which involved a strong impact on the current business model of higher education institutions, this clearly exposed strong gaps in the way to innovate in this emerging business format and that in many cases involves technological elements, digital resources (hardware and software), processes and technical support and a conservative academic culture that were not considered, adding to this the level of digital literacy that users possess (Jackson, 2019; Bertola and Vandi, 2020; Pérez-Fernández *et al.*, 2020; Vicente *et al.*, 2020; Farias-Gaytan, Aguaded and Ramirez-Montoya, 2022)

For this, the university system must take extreme measures to maintain quality education, involving university culture, technological innovation, methodologies, and teaching-learning that allow them to be competitive in the face of a scenario that has been more disruptive in education significantly increasing competition among these institutions. Among the technological measures to be in force within this industry is the use of collaborative environments in the cloud, web platforms, massive online trainings, flipped classroom, collective intelligence, finding cases of success through the edition of wikis (Van Den Berg, 2018; Mareca and Bordel, 2019; Rodríguez-Abitia *et al.*, 2020; García-Morales, Garrido-Moreno and Martín-Rojas, 2021) .

Under this scenario, the methodological strategies addressed range from legal education using global competencies and scenario studies, in the administrative area they strengthened a digital preparation and cultural openness to technological innovation, using facilitators for digital literacy processes under a strategic orientation in the current scenario. For the engineering field they used approaches based on Active Learning and Challenge-Based Learning for the development of critical and creative thinking skills (Agasisti et al., 2020; Campolina, 2021; Caratozzolo et al., 2021a; Mora and Sánchez, 2020).

It is also important to highlight that the challenges of higher education institutions regarding the quality of e-learning go beyond the mere technical component, thus establishing relationship, information, and communication technologies (TRIC), which must validate the training process itself. Now, the challenge transcends the combination of learning methodologies that promotes in the teaching role the linking of pedagogical strategies supported by Gamification. The TRICs have transformed the current learning environment, going from a traditional one centered on the teacher to one centered on the student (García, Reyes and Godínez, 2017). Technological instruments by themselves will not improve work in the classroom; a greater effort is required to consider formative and content aspects that involve the participants. It is considered that Tics are increasingly friendly, accessible, and adapted to the action of the tutor. The teacher and the educational institution can incorporate ICTs to generate improvements in the didactic action; in this way, it is possible to move from traditional teaching towards more collaborative and networked learning (Mendoza, Burbano and Valdivieso, 2019).

Complementing the above, the evolutionary trend of the digital transformation of higher education institutions is heading towards the "Smart Campus", or intelligent fields that use information and communication technologies (ICT) to interact with the interested parties and create an ecosystem that integrates physical and digital spaces, establishing receptive, intelligent, and improved services to create a productive, creative, and sustainable environment (Min-Allah and Alrashed, 2020; Villegas-Ch, Arias-Navarrete and Palacios-Pacheco, 2020). The process of smartization of universities aims to change the current framework to evolve towards a concept of an open university. It aims to adapt the management model, infrastructures, and relations with the community towards a common objective: sustainability and quality of life (Rico-Bautista *et al.*, 2020).

Within the measures associated with cognitive and metacognitive experiences, creativity, citizenship, and interpersonal skills processes stand out. Other campuses have focused on inverted teaching to boost results and other competencies such as effective communication, character formation, comprehensive reading, collaborative work, critical thinking, or creativity. They have also strived to strengthen attitudes and values for the complex demands of the Fourth Industrial Revolution, with industry and academia partnering crucially to develop cross-cutting and disciplinary skills in students, challenging them to solve real problems in real environments. Within these interactive and integral learning advances is GLOBE which focuses on competencies around ICT and virtual collaboration with real-world actors (Bresinsky and von Reusner, 2018; Caratozzolo, Alvarez-Delgado and Hosseini, 2021; Stolze *et al.*, 2021; Suárez *et al.*, 2021; Lara-Prieto and Flores-Garza, 2022).

2 Materials and Methods

A set of articles was used as a homogeneous citation base, avoiding the impossibility of comparing indexing databases that use different calculation bases to determine journals' impact factors and quartiles (Bakkalbasi *et al.*, 2006; Falagas *et al.*, 2008; Chadegani *et al.*, 2013; Harzing and Alakangas, 2016; Mongeon and Paul-Hus, 2016), relying on the Web of Science (WoS) core collection (Clarivate, 2022) selecting documents published in journals indexed by WoS in Emerging Sources Citation Index (ESCI), Science Citation Index Expanded (SCIE) and Social Science Citation Index (SSCI), Conference Proceedings Citation Index - Science (CPCI-S); Conference Proceedings Citation Index - Social Science & Humanities (CPCI-SSH), from a search vector on Digital

Transformation in the Higher Education TS=(Digital NEAR/0 transformation) AND (Higher NEAR/0 education), without restricted temporal parameters, performing the extraction on October 15, 2022. The following types of documents were included: articles, meeting abstract, review, editorial material, book review and letter.

A bibliometric analysis was carried out on a set article and other scientific documents obtained for the Digital Transformation in the Higher Education (DT2HE) topic. Reviewing the fundamental bibliometric laws:

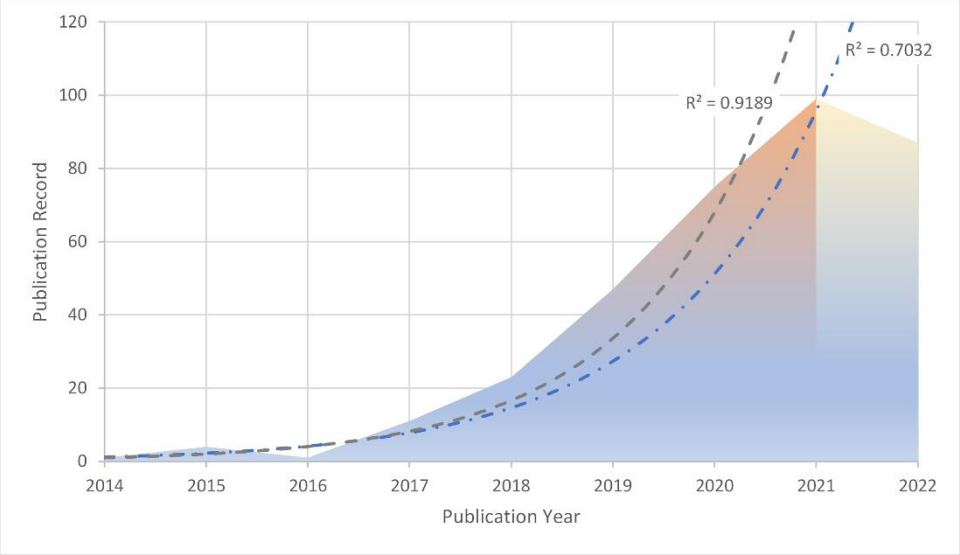
1. Exponential science growth or Price's Law, through the exponential adjustment degree of the annual growth of publications, as a measure of a strong interest among the scientific community to develop studies on DT2HE, conforming a critical researcher mass developing this knowledge topic (Price, 1976; Dobrov, Randolph and Rauch, 1979).
2. Publications concentration in journals or Bradford's Law, distributing the journals in thirds according to the decreasing number of documents published in them, establishing as the nucleus of journals with the highest concentration that cover at least 33% of the total publications (Bulick, 1978; Morse and Leimkuhler, 1979).
3. Publications concentration in authors or Lotka's Law, recognizing that in any knowledge field, most of the articles come from a small proportion of prolific authors, who, being identified, can be studied in isolation (Coile, 1977), information that has been complemented with WoS Author (Clarivate, 2022).
4. Citations concentration in articles or Hirsch index (h-index), thus considering the "n" articles cited at least "n" times or more, a concentration that is extended by transitivity to their authors (author h-index, based on their publications) (Hirsch, 2005).
5. Keyword concentration or Zipf's Law, highlighting the most used keywords in the article set (Zipf, 1932).

Finally, VOSviewer software was used to perform the processing and visualization of the dataset, as well as co-occurrence, performing a fragmentation analysis with clustered visualization outputs (Waltman, Van Eck and Noyons, 2010; Perianes-Rodriguez, Waltman and van Eck, 2016; Araya-Castillo *et al.*, 2022)

3 Results

A total of 384 papers were extracted between 2014 and 2022 (table S1: DT2HE.xlsx, and table S2: DT2HE.txt for VOSviewer). An exponential growth can be seen with R^2 = 92% for full years (2014-2021), and R^2 = 70% for all years, covering a total of 384 articles in that period (Figure 1).

Figure 1 Temporary trend of publications on physical literacy (2014–2022).



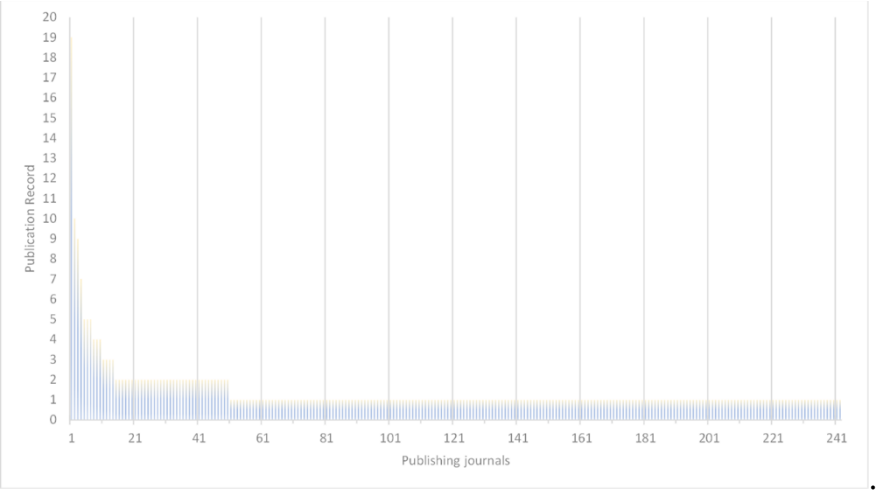
Most documents extracted were articles (206, 59.2%), followed by proceedings paper (132, 37.9%), and reviews (10, 2.9%).

Table 1 Extracted document type by WoS Index

WoS Index	Artic.	Artic. & Data Paper	Artic. & Early Access	Artic. & Proc. Paper	Proc. Paper	Review	Total
ESCI	116	1	9	2	0	5	133
CPCI-SSH	0	0	0	0	57	0	57
CPCI-S	0	0	0	0	56	0	56
SSCI	39	0	2	0	0	1	42
SCI-EXPANDED & SSCI	28	0	1	0	0	2	31
CPCI-S & CPCI-SSH	0	0	0	0	19	0	19
SCI-EXPANDED	7	0	1	0	0	2	10
Total	190	1	13	2	132	10	348

Bradford's law is not suitable for identifying the main journals that publish in DT2HE (Bulick, 1978; Morse and Leimkuhler, 1979). Considering the high dispersion of 242 journals or proceedings book for the publication of the 348 documents extracted, 192 of these record sources present only one published document, and 36 others present only 2 documents (see Figure 2).

Figure 2 Publications by journal on DT2HE (2014–2022)



According to the previous result, we show in Table 2, a limited number of 14 journals that published more than 2 papers on DT2HE in the period studied. These journals concentrate a percentage lower than the 1/3 of documents that the Bradford journal nucleus should contain, achieving only 24% (=84/348).

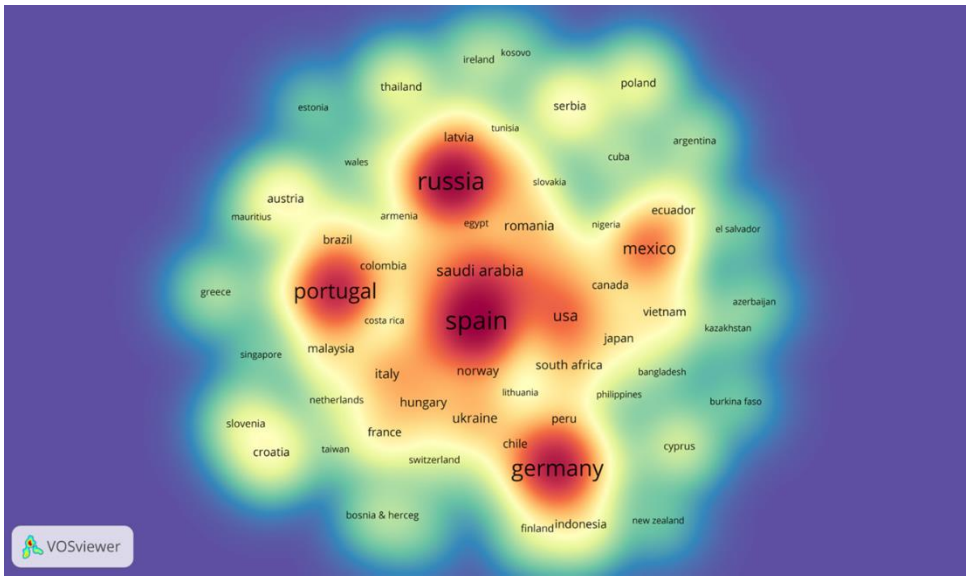
Table 2 Journals with more than 2 publications ranked according to Bradford's Law

Source	**Total Docs.**	**Fr.**	**Total Citations***	**Quartile (JCR2021)**	**Open access**
Sustainability	19	5.5%	274	Q2	100%
Education Sciences	10	2.9%	72	ESCI	100%
Education and Information Technologies	9	2.6%	55	Q1	78%
13th International Technology, Education and Development Conference (Inted2019)	7	2.0%	34	Conference	N/A
Proceedings Of The 2022 IEEE Global Engineering Education Conference (Educon 2022)	5	1.4%	1	Conference	N/A
14th International Technology, Education and Development Conference (Inted2020)	5	1.4%	0	Conference	N/A
Edulearn19: 11th International Conference on Education and New Learning Technologies	5	1.4%	1	Conference	N/A
RIED-Revista Iberoamericana De Educación a Distancia	4	1.1%	4	Q2	100%
11th International Conference of Education, Research, and Innovation (Iceri2018)	4	1.1%	4	Conference	N/A
Information Technologies and Learning Tools	4	1.1%	19	ESCI	100%
Red-Revista De Educación A Distancia	3	0.9%	20	ESCI	100%
International Journal of Educational Technology in Higher Education	3	0.9%	112	Q1	100%
International Journal of Emerging Technologies in Learning	3	0.9%	6	ESCI	100%
International Journal of Advanced Computer Science and Applications	3	0.9%	9	ESCI	0%
Others Journals	264	76%	1034	N/A	13/264
Total	348	100%	1645	N/A	47%

N/A: not applicable, * Times Cited, WoS Core.

Seventy-two countries were found with at least one publication, but only 50 of these are strongly related, forming a global knowledge community in DT2HE, the other 22 countries produce knowledge alone or in dyads, remaining outside the heat zone of Figure 3. In addition, there are four countries with high production: Spain (42 documents), Russia (40), Germany (34), Portugal (30).

Figure 3 Country/region heat map on DT2HE.



In co-authorship at the country or region level, Spain, England, Germany, and the USA lead the international collaboration, leaving Portugal and Russia behind, as shown in Table 3.

Table 3 Main international collaboration by country/region

Country/Region	Published documents	Total links strength	Connected Country/Region
Spain	42	26	19
England	9	20	17
Germany	34	20	17
USA	15	20	14
Portugal	30	8	6
Russia	40	7	7

The total of 348 extracted documents the result of the scientific production of 1,048 authors, so the number of prolific authors is estimated by Lotka's Law in 32 (Square Root (1,048) ≈32.37)) (Coile, 1977). But seventy-five authors published more than two articles, and only 16 researchers released more than 3, so a more demanding criterion was taken, a concentration slightly higher than 1% of the identified authors. When mapping with VOSviewer the 16 prolific authors with more than 3 articles, not all are related to each other. Figure 4 shows seven prolific author clusters, one alone prolific research, four dyads, one triad, and one tetrad. The production levels do not indicate large differences as they only exceed 3 publications: Fernando Moreira, María Joao Ferreira, and Isabel Seruca, but the average citation level of their papers shows a clear difference in the

interest in the works of Abad-Segura and González-Zamar, with respect to the other fourteen authors.

Figure 4 Prolific co-authors graph on DT2HE.

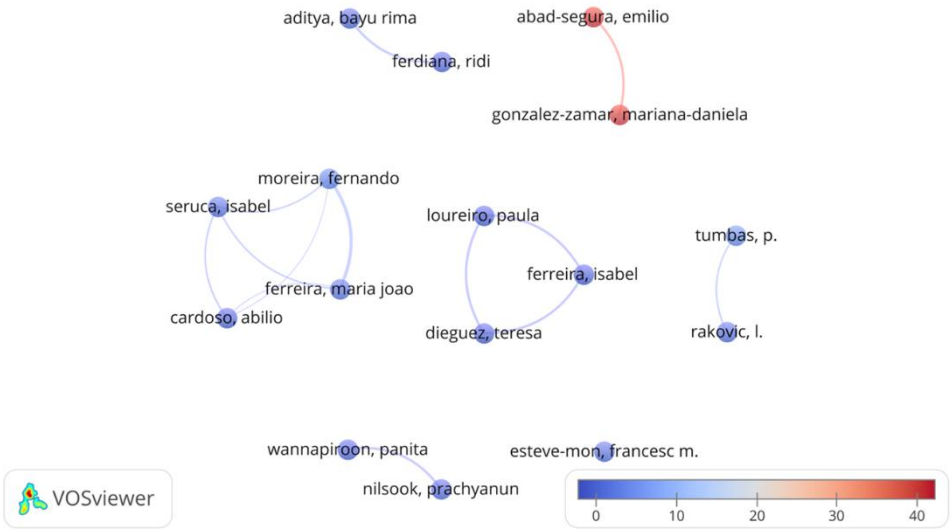


Table 4 describes the authors, their work in DT2HE and their contribution and personal impact in WoS through their h-index as researcher, being necessary to detail the records associated with their OrcID to reduce inaccuracies of their digital identity. In detailing aspects presented in the graph in Figure 4, the most numerous clusters (4 and 3 researchers) are affiliated to Portugal, the dyads to Indonesia, Serbia, Spain and Thailand and the lone prolific researcher are also affiliated to Spain. Finally, it is observed that the prolific authors with the most citations in DT2HE, both from the Univ. Almeria, are also the ones with the highest h-index in WoS.

Table 4 Prolific authors, descriptions of their work in DT2HE and overall h-index in WoS.

Prolific authors (OrcID)	**Affiliation**	**Country**	**Documents**	**Citations**	**h-index WoS**
Moreira, F. (0000-0002-0816-1445)	Univ. Portucalense; Univ. Aveiro	Portugal	5	20	9
Ferreira, M.J. (0000-0003-4274-8845)	Univ. Portucalense; Univ. Minho	Portugal	4	8	3
Seruca, I. (0000-0002-9951-6378)	Univ. Portucalense; Univ. Minho	Portugal	4	8	5
Abad-Segura, E. (0000-0001-8624-103X)	Univ. Almeria	Spain	3	115	16
González-Zamar, M.D. (0000-0003-1187-8970)	Univ. Almeria	Spain	3	115	14
Tumbas, P. (0000-0003-1738-8219)	Univ. Novi Sad	Serbia	3	14	5
Esteve-Mon, F.M. (0000-0003-4884-1485)	Univ. Jaume 1	Spain	3	4	11
Rakovic, L. (0000-0002-1465-588X)	Univ. Novi Sad	Serbia	3	4	3
Aditya, B.R.	Gadjah Mada Univ.; Telkom Univ.	Indonesia	3	3	3

(0000-0002-3267-7214)					
Ferdiana, R. (0000-0001-9961-5205)	Gadjah Mada Univ.	Indonesia	3	3	5
Nilsook, P. (0000-0003-3019-3635)	King Mongkuts Univ Technol North Bangkok	Thailand	3	2	6
Wannapiroon, P. (RID: AAV-8301-2021)*	King Mongkuts Univ Technol North Bangkok	Thailand	3	2	7
Cardoso, A. (0000-0002-0829-3982)	Univ. Portucalense; Univ. Minho	Portugal	3	1	5
Dieguez, T. (0000-0002-4886-1446)	Polytech. Inst. of Cávado and Ave	Portugal	3	1	1
Ferreira, I. (RID: FYS-6464-2022)*	Polytech. Inst. of Cávado and Ave	Portugal	3	1	1
Loureiro, P. (N/A)	Polytech. Inst. of Cávado and Ave	Portugal	3	1	N/A

* OrcID non-available, using WoS ResearchID.

Eighteen documents were found with 18 or more citations (h-index = 18). Table 5 shows that these 18 documents with 19 to 182 citations have been published in 12 journals and one Proccedings (Inted2019), with a concentration of 33.3% of the publications in the journal Sustainability, being the number of documents published in the other 12 sources equal to 1. At the level of publishers, MDPI (Educ. Sci., Sensors, and Sustainability) has the highest concentration (44.4%) followed by Elsevier concentrating 1/6 of the documents. Additionally, the only prolific authors participating in the h-index are Emilio Abad-Segura (0000-0001-8624-103X) and Mariana Daniela González-Zamar (0000-0003-1187-8970), both affiliated to the Almeria University (Spain).

Table 5 Documents in h-index 18.

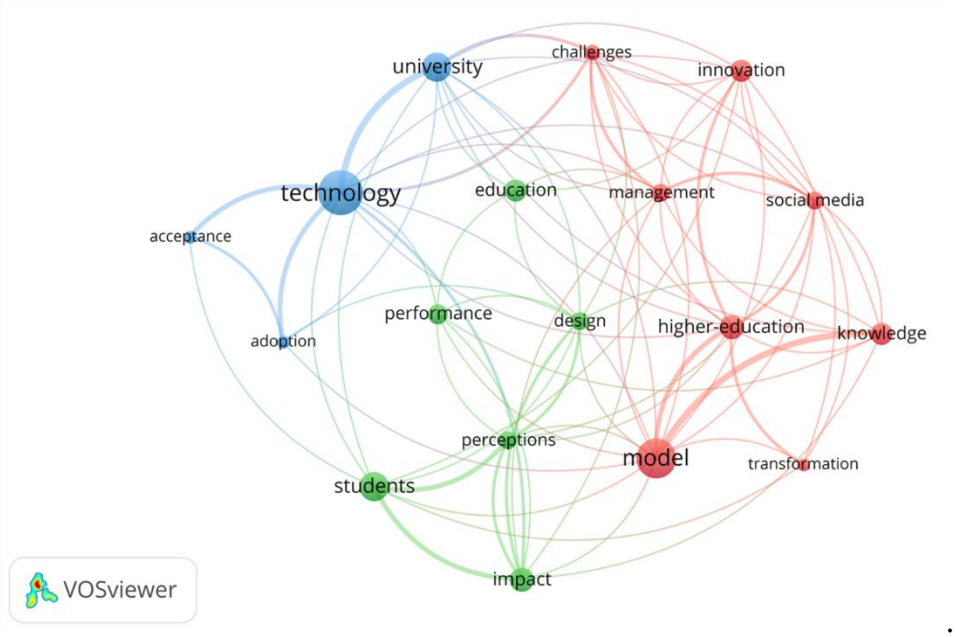
Authors	**Documents in h-index 18**	**Journal**	**Times Cited***
Iivari, N; Sharma, S; Venta-Olkkonen, L	Digital transformation of everyday life - How COVID-19 pandemic transformed the basic education of the young generation and why information management research should care?	Int. J. Inf. Manage.	182
Bond, M; Marin, VI; Dolch, C; Bedenlier, S; Zawacki-Richter, O.	Digital transformation in German higher education: student and teacher perceptions and usage of digital media	Int. J. Educ. Technol. High. Educ.	106
Garcia-Penalvo, FJ; Corell, A; Abella-Garcia, V; Grande, M	Online Assessment in Higher Education in the Time of COVID-19	Educ. Knowl. Soc.	105
Garcia-Penalvo, FJ; Corell, A	The COVID-19: the enzyme of the digital transformation of teaching or the reflection of a methodological and competence crisis in higher education?	Campus Virtuales	75
Abad-Segura, E**; González-Zamar, MD**; Aand, JCIM; Garcia, GR	Sustainable Management of Digital Transformation in Higher Education: Global Research Trends	Sustainability***	72
Garcia-Morales, VJ; Garrido-Moreno, A; Martin-Rojas, R	The Transformation of Higher Education After the COVID Disruption: Emerging Challenges in an Online Learning Scenario	Front. Psychol.	68

Mhlanga, D; Moloi, T	COVID-19 and the Digital Transformation of Education: What Are We Learning on 4IR in South Africa?	Educ. Sci.***	59
Sa, MJ; Serpa, S	The COVID-19 Pandemic as an Opportunity to Foster the Sustainable Development of Teaching in Higher Education	Sustainability***	38
Kompen, RT; Edirisingha, P; Canaleta, X; Alsina, M; Monguet, JM	Personal learning Environments based on Web 2.0 services in higher education	Telemat. Inform.	35
Jackson, NC	Managing for competency with innovation it changes in higher education: Examining the pitfalls and pivots of digital transformation	Bus. Horiz.	32
Mian, SH; Salah, B; Ameen, W; Moiduddin, K; Alkhalefah, H	Adapting Universities for Sustainability Education in Industry 4.0: Channel of Challenges and Opportunities	Sustainability***	31
Garcia-Penalvo, FJ	Avoiding the Dark Side of Digital Transformation in Teaching. An Institutional Reference Framework for eLearning in Higher Education	Sustainability***	30
Kopp, M; Groblinger, O; Adams, S	Five common assumptions that prevent digital transformation at higher education institutions		28
Bhagat, S; Kim, DJ	Higher Education Amidst COVID-19: Challenges and Silver Lining	Inf. Syst. Manage.	27
Abad-Segura, E**; González-Zamar, MD**; Luque-de la Rosa, A; Cevallos, MBM	Sustainability of Educational Technologies: An Approach to Augmented Reality Research	Sustainability***	24
Benavides, LMC; Arias, JAT; Serna, MDA; Bedoya, JWB; Burgos, D	Digital Transformation in Higher Education Institutions: A Systematic Literature Review	Sensors	21
Tay, HL; Low, SWK	Digitalization of learning resources in a HEI - a lean management perspective	Int. J. Product Perform. Manag.	21
González-Zamar, MD**; Abad-Segura, E**; Lopez-Meneses, E; Gomez-Galan, J	Managing ICT for Sustainable Education: Research Analysis in the Context of Higher Education	Sustainability***	19

*Times Cited according to WoS Core Collection (until 15 October 2022); **Prolific authors; *** Main journals.

Concerning the Zipf law, outstanding keywords plus are 18 (= square root (313)) and three clusters were identified, as it is represented in Figure 5. First cluster relates in red with 8 items is related to the modernization goals in higher education because of the digital transformation (Rof, Bikfalvi and Marquès, 2020; Stolze *et al.*, 2021; Busulwa, Pickering and Mao, 2022; Garcez, Silva and Franco, 2022). The second cluster in green with 6 items is oriented to the effects on students produced by DT2HE (Badwelan and Bahaddad, 2021; Fuentes, Estrada and Delgado, 2021; Jost *et al.*, 2021; Loukatos *et al.*, 2022; Low and Wong, 2023). Finally, the third cluster in blue with four items emphasizes the DT2HE process itself (Bond *et al.*, 2018; Xiao, 2019; Secundo, Rippa and Meoli, 2020; Pilav-Velić *et al.*, 2021; Nurhas *et al.*, 2022).

Figure 5 Keywords plus graph



4 Discussion and Conclusions

The objective of this bibliometric study was to provide a basis for analysing the development and evolution of scientific literature related to digital transformation in higher education institutions, it contributes to establishing an overview of trends in scientific production worldwide. In the development of the article, bibliometric studies have been found with some coincidences and in other cases with differences. With the studies by the authors González-Zamar *et al.* (2020) and Abad-Segura *et al.* (2020), there is a coincidence in a growing interest in knowing the phenomenon of digitization, either from the skills necessary for the transformation digital and digitization processes in educational organizations. The studies by González-Zamar *et al.* (2020) with their article: "ICT Management for Sustainable Education: Research analysis in the context of higher education", focus on the use of ICTs as a medium that favors the development of sustainable education, forming more responsible and conscientious students. Likewise, the studies by Adad-Segura *et al.* (2020) with their article: "Sustainable Management of Digital Transformation in Higher Education: Global Research Trends", show the importance of "sustainable management" to adapt to the changes imposed by new technologies in the educational sector. Both studies had "Scopus" as their database.

The first analyzed information from the years 2000 to 2019, while the second did so between the period 1986-2019. In relation to the topics investigated, the studies by González-Zamar *et al.* (2020) are like our article in relation to the topics in "education", "information technologies" and "higher education". In relation to the differences, there is the Source of information extraction since our work was based on information from the "Web on Science (Wos)". In addition, the countries that present the greatest scientific production in the articles mentioned are the United States, the United Kingdom, Australia, China, and Italy, while in our article Spain, Russia, Portugal, and Germany stand out as countries with the greatest scientific production related to Transformation. Digital in Higher Education. In addition, our article takes more up-to-date information, considering information between the years 2014 and 2022, incorporating the Covid-19 pandemic,

which accelerated the digital transformation in the analyzed institutions. Regarding the main authors, in the article by González-Zamar *et al.* (2020), the authors are Mulder, Cappellaro, Cotana, Cumo, Eisenmenger and Ferrer-Balas. Similarly, in the article by Abad-Segura *et al.* (2020), the main author is Mulder, from The Hague University of Applied Sciences. In this, there are differences with our article, since the main author is Moreira, from the University of Aveiro, Portugal. There are also differences in the topics studied in relation to the article by Abad-Segura *et al.* (2020), since the latter focuses on issues of social sciences and environmental sciences.

There is another article by the authors Reis-Marques, *et al.* (2021), entitled: "Applications of blockchain technology to the field of higher education: a bibliometric analysis" whose purpose is to safeguard the security of information in higher education, which also points to an information technology in support of the transformation processes of higher education, for which, there are also similarities in terms of the promotion of digital transformation in this sector and the period of years in which it was based. Research, which focused on pandemic periods (2016-2021). On the contrary, there are differences since again the database is Scopus and the countries that produce the most are the US, China, India, and Portugal.

When carrying out an exhaustive analysis of the scientific production related to the "Digital Transformation" it is evident that there are several bibliometric studies on this subject, however, most of said investigations are related to the digital transformation, but in commercial or service organizations and not in higher education, and especially in universities.

With the purpose of publicizing the research findings, a review of the fundamental bibliometric laws was carried out, beginning with Price's Law, which showed an exponential growth in the number of publications (R2 = 92%) between the years 2014 to 2021, within a universe of 384 documents analyzed. At the same time, a marked increase in scientific production is inferred from the year 2019. Coinciding precisely with the presence of Covid-19, which was a variable that motivated the generation of articles, proceedings, and reviews, related to digital transformation. in organizational processes, accelerating this transformation to levels never seen before. Link the above finding to the reference research question described as:

As for the Bradford Law, which shows us the level of concentration of publications by journals, on DT2HE, between the years 2014-2022, a limited number of journals (14 journals) is evident, the most prominent being: "Sustainability", "Science Education" and "Education and Information Technology", concentrating a total of 38 documents with an accumulated frequency of 11% compared to the total sources analyzed. A low production of DT2HE by the journals is evident.

Regarding the countries that carry out scientific production related to DT2HE, the Heat Map evidenced a global community of knowledge, and a strong relationship on this topic, made up of 50 countries, of which stand out within the area of greatest heat: Russia, Germany, Spain, Portugal, and Mexico, forming a cluster of high scientific production. Related to the above, with the level of collaboration between countries in terms of co-authorship, the US, as a country outside the European and Asian zone, is among the leading countries in terms of international collaboration, with a total of 20 links of strength, together with Spain. England and Germany, not so, Portugal (8 links) and Russia (7 links) that have links of low strength or collaboration.

Referring to Lotka's Law, which reveals the concentration of publications by author, it shows a low collaboration among the top prolific authors in terms of co-authorship, since there are only 16 authors who publish more than three intelligent articles. Within

these 16 there is no relationship between them, but groupings into dyads, triads, and tetrads, and, in addition, there is an isolated author. Regarding the co-authorship networks, the main ones are in clusters of 4 and 3 authors and affiliated to Portugal at the same time.

Complementing the above but considering Hirsch's Law ("h" index, or how relevant an article is in terms of citations), the authors with the most citations are: Abad-Segura, and González-Zamar; both with 115 citations each, in WoS, and representing Spain through the University of Almería, followed by Moreira, F. with 20 citations, from Portugal from the Universidad Portucalense; Aveiro from Portugal.

It is important to highlight the high concentration of documents in the "h" index belonging to the "Sustainability" magazine, which reaches 33.3% of the publications together with a concentration of 44.4% at the editorial level. The authors: Emilio Abad-Segura and Mariana Daniela González-Zamar are the most prominent authors in the "h" index.

Regarding According to Zipf's Law, three clusters of groups of most prominent words (used) are observed, with force in the words: Model (red), Students (green), Technology (blue) linked to: "modernization in the Pandemic higher education", "the effects of DT2HE on students" and the "DT2HE process", respectively.

Given the above, this work reveals the low scientific production in the field of digital transformation in universities, and at the same time, raises the concern of making proposals for constructs that serve to implement and control digital transformation processes in universities. leading these institutions. in levels of digital maturity that directly impact the satisfaction of their students.

One of the main conclusions of this study is the little research carried out on digitalization in higher education institutions, however, from 2019 onwards there was an exponential increase in scientific production on digital transformation issues. but in different areas. Where the main driver was probably the covid-19 pandemic. Many public and private organizations, with and without profit, saw the need to digitize their different Value Chain processes. The idea that the search vector was limited to "higher education institutions" has to do with generating basic information to develop a proposal for a digital maturity model that allows measuring the degree of digital transformation of a university.

Supplementary Materials: The following supporting information can be downloaded at: www.mdpi.com/xxx/s1, Table S1: DT2HE.xlsx (for MS-Office), and www.mdpi.com/xxx/s2, Table S2: DT2HE.txt (for VOSviewer).

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ARTÍCULO 2

Digital transformation model for universities: a preliminary proposal

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Digital transformation model for universities: a preliminary proposal

Abstract

This article shows the results of a research whose objective was to design a theoretical model of digital transformation for the Autonomous University of Chile. The research design corresponds to a case study with a mixed approach: quantitative and qualitative, which allowed obtaining contextualized and in-depth knowledge about the dimensions and factors that structure said digital transformation model, considering the contributions offered by 97 students and eight experts. The model is structured in three phases, 9 dimensions and 54 indicators, highlighting the close relationship between digital maturity and the generation of value for the student. The main determinants of success in the digital transformation processes of this University are specified, among which stand out: the strategic approach and the organizational culture, as well as the way to take advantage of the available technological infrastructure and the capacities to manage technology. The article ends by exposing the factors that determine the capacity of this educational institution to introduce technological changes that respond to its strategic, technical, and logistical needs. It also suggests carrying out new studies leading to redefining the roles of the administrative, teaching and student staff that allow increasing the level of digital maturity of the University, the continuous innovation of services and processes, and the creation of new digital learning spaces focused on the student.

Keywords: digital transformation, digital maturity, educational technology, higher education, information technology, IT governance, teaching-learning process, technological basis.

1. Introduction

The value offered by information technologies 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 its 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 et al., 2020). This evolution implies the adoption of strategic thinking oriented towards 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 et al., 2015).

In the context of higher education, which shows different characteristics from other industrial and service sectors, figures have not yet been found that allow elucidating the success rate in digital transformation projects (Catlin et al., 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); even, on occasions, it has not even obeyed a 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 contrary to change, poor planning for digitization and unavailability of the financial resources necessary to execute the plans (Rodríguez-Abitia & Bribiesca-Correa, 2021). Even if it is true that the development of a specific set of digital capabilities leads to a greater digital maturity, and there is a whole conceptual base and a model to evaluate the effectiveness of digital transformation efforts in companies (Castro et al., 2022), it is still not there is a 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 or the simple acquisition of technological platforms to support academic processes, as happened in the context of the Covid-19 pandemic, but rather implies 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 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 make the most of the changes and opportunities offered by digital technologies (Demirkan et al., 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, that begins with the use of digital technologies to later evolve towards the holistic digital transformation of the organization (Teichert, 2019). With the 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, 2015, cited in Xu et.al., 2018), there are still organizations that fail to change their work routines, processes, structure and culture (Almatrodi & Skoumpopoulou, 2023) having broad implications for strategic management, governance, knowledge management and innovation.

The dynamic and evolutionary nature of the 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), but relatively recent theoretical developments in transformation practices digital 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 the Chilean case, for example, in 2019 there were 61 universities that concentrated an enrollment of 749 thousand students distributed in technical and professional careers, in addition to postgraduate programs (Kerrigan, 2020) but, although all of them carry out their own activities for identify and anticipate the digital skills required by the labor market, no studies have been found that reflect the factors that have been 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, in light of the

profound changes that are taking place in cultural, political, social, economic and technological matters, allows addressing the different areas of university activity in terms of the online teaching modality, the science and innovation system, the digitization of knowledge, and the digitization of university management itself. In this sense, although it is true that digital transformation in the university context is not a recent issue, there is still no uniform understanding of its implications or the way to manage it (Kopp et al., 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 dimensions and 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 the digital transformation that the Autonomous University of Chile can implement?

This investigation is part of a broader one, having been fundamentally oriented to elaborate the theoretical design of the digital transformation model of this University, using a small sample and without trying to validate it using factorial analysis, for which reason the results have not yet been obtained. they can be generalized. Nor was it intended to determine the new functions and responsibilities of the teaching and administrative staff required to manage the transformation process, increase the level of digital maturity of the University, promote the creation of new digital spaces focused on the student, 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 perspective, digital transformation has been defined from various approaches. For example, it has been understood as a process of change, disruptive or incremental, that begins with the use of digital technologies to later evolve towards the holistic digital transformation of the organization (Teichert, 2019); and as "a process that aims to improve an entity by causing significant changes in its properties through combinations of information, computing, communication and connectivity technologies" (Vial, 2019, p. 119). It has also been defined as an organizational transformation process (Brdesee, 2021) that facilitates the development of new models and competencies, strategically supported by digit al technologies and information on student success factors, resource allocation, and the effectiveness of educational and institutional programs (Marks et al., 2016).

Another perspective assumes that digital transformation is "the deep and accelerated transformation of activities, processes, competencies and business models to take full advantage of the changes and opportunities offered by digital technologies [...] in a strategic and prioritized manner" (Demirkan et al., 2016, p. 14), while other authors conceive digital transformation, not as a transformation process, but 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). In similar terms, it has also been defined as a strategic process oriented towards the integration of digital

technologies, such as data analysis and automation, which generate changes in work routines, processes, structure and culture (Almatrodi & Skoumpopoulou, 2023)

However, regardless of the approach used, there is some degree of agreement in the literature that the digital transformation process transcends the inherently technological and expands to the organization, with enough power to affect its cultural and structural attributes. This is consistent with the statement made by Hess et al. (2016) when they point out that this process not only impacts the emergence of new business models and the improvement of the customer experience, but also the redefinition of business objectives, leadership, and hierarchical structures.

The complexity of the aspects that intervene in the digital transformation has been argued by Rossman (2019) when pointing out the need to develop a set of capacities linked to leadership, the market, operations, people and skills, 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 et al., 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).

According to Brdesee (2021), digital transformation is based on five fundamental pillars: (1) a digital business strategy, (2) the organization's commitment to customers and users; (3) presence of a culture of innovation; (4) technology; and (5) data analysis. From this it can be deduced that digital transformation transcends technological frontiers to become a strategic component of the value creation system. So much so that it has been stated that the true engine of digital transformation is strategy, not technology (Kane et al., 2015), which seems to be corroborated by Bounfour (2016) when outlining four dimensions of digital transformation: the purpose, the scope or degree of digitization, the speed of implementation of the digital transformation strategy, and the sources of value creation in the digital space, as well as by Hess et al. (2016) who argue that the basic components of said strategy are: (1) the use of technologies, which reflects the focus and capacity of organizations to take advantage of the potential of new digital technologies; (2) changes in value creation, which reflect the influence of digital transformation on the value proposition; (3) structural changes, which affect the organization, processes, and skills needed to manage new technologies; and (4) the financial dimension, which relates to the organization's ability to finance a digital transformation effort.

Considering the above, it is inferred that any digital transformation process is characterized by an implicit complexity, which forces organizations to use a systematic approach that considers the multiple dimensions that transcend the technological frontier. The absence of this broad and holistic approach could make it difficult to identify problems in a timely manner or ignore the most favorable solutions for the specific situations of each organization.

2.2. Digital transformation in higher education institutions

The literature on the maturity of digital transformation in higher education is scarce (Marks et al., 2020). The experience lived with the Covid-19 crisis and the accelerated development of digitization not only changed the conditions in which the educational event occurs but has also modified the foundations of education itself (Stare et al., 2023). For this reason, teachers and students face the challenge of strengthening their digital skills, understanding these as a dynamic combination of skills, knowledge, and ways of thinking about information, communication, and digital technologies (Saienko et al., 2022).

This dynamism is driven by the deep and massive changes that are taking place in a context of high volatility, uncertainty, complexity, and ambiguity (Nowacka & Rzemieniak, 2022) in which not only the adoption of technologies by companies and consumers is accelerating, but also the ability to innovation. 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 et al., 2018).

The phenomenon of digital transformation has been widely explored in different academic domains, but knowledge about this object of study is still fragmented, ignoring the existence of a methodology that allows digitizing business models, the stages that must be considered and the factors that enhance this process (Sayabek et al., 2020). It has even been pointed out that the main concern in this transformation is to define a vision and a roadmap that determine the path to follow (Zaoui & Souissi, 2020), but in the context of higher education, even when universities strive by offering complete, up-to-date and consistent information about their key assets to their many users through various digital services and communication channels, they also face the added challenge of sorting out the diversity of intrinsic data that is duplicated and dispersed, making it difficult to correlate due to the different formats used, conventions and terminology used (Maltese, 2018). These are factors that threaten organizational efficiency, being precisely the digital transformation the most important factor that sustains this impulse (Brdesee, 2021).

However, as García-Peñalvo (2021) points out, the development of digital skills in higher education institutions has meant a positive leap; however, if the maturity of the digital transformation strategies is analyzed, it can be deduced that the objective of achieving a 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 most important social, cultural, economic, and environmental dimensions (Cerdá et al., 2021).

In this sense, considering the fundamental mission of higher education institutions, and understanding digital transformation as a response to the context of development on the global scene (Bagdasarian et al., 2020), it is evident that the university, initially seen as an organization, must be transformed internally to be able to play its pivotal role in today's digital ecosystem; but at the same time, seen as a reliable channel of knowledge distribution for society, the university is also called 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).

This implies a better understanding of the needs of the labor market, of society and of its students, teachers, and researchers; it must also generate a culture of collaboration, with greater flexibility, more agility and with better adaptability. According to the authors, this transformation "must be approached without delay, but also with a critical and reflective approach under the particularities of each institution" (Chinkes & Julien, 2019, p. 33), but in any case, through investment in capacities digital, whose development 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, in technology" (Lorenzo, 2016, p. 574).

Another interesting contribution to the literature is the one offered by Awdziej et al. (2023) when arguing that the success of the digital transformation of universities requires

that a culture of digital maturity of all interested parties be added to the technical and support infrastructure. In other words, on the one hand, the staff working at the university must possess the necessary skills and knowledge to design and offer digital learning experiences to students, but on the other hand, they students must possess sufficient capacity to use effective digital tools made available to promote learning and personal development, making ethical and responsible use of technology, critical thinking, and digital citizenship.

In any case, 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 between politics, economics, science, technology, and society (Mohamed, Tlemsani, & Matthews, 2022).

2.3. Models of digital transformation

In the research literature about digital transformation "models do not play a prominent role" (Gray & Rumpe, 2017, p. 307). 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, Tlemsani, & Duncan, 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 that 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 at the same time a careful process of management and control. (Mohamed, Tlemsani, & Duncan, 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 et al., (2012), who after demonstrating the existence of a clear correlation between digitization and competitiveness, designed a model that it offered an integrated structure that allowed any type of organization to evolve gradually and progressively in 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 are reacting to digital opportunities, and designed a pioneering model called the "Digital Maturity Indicator" (IMD), with four levels of maturity that depended 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, understood as 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 (Table 1).

Table 2

Digital Maturity Indicator model

DIGITAL IDENTITY		
	High digital intensity and low transformation management intensity Fashionistas or followers of digital fashion, 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 masters 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 manage to 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 comprehensive transformation vision.	**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 very skeptical about the value of digital in these processes. Although willing to invest in digital change, their slowness makes them lose opportunities to the detriment of other riskier organizations.
	INTENSITY OF TRANSFORMATION MANAGEMENT	

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

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

Table 2

Dimensions and factors of McKinsey Digital Quotient model

Dimensions	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: Adapted from McKinsey Composite (Catlin et al, 2015)

In this model, the starting point is the definition of a clear and precise digital strategy, which is integrated into the company's corporate strategy and whose alignment is key to the success of the digital transformation. According to the authors, designing a correct digital strategy involves answering three key questions: where are the most relevant opportunities and threats? How fast and at what scale could a digital disruption occur in my sector? And what are the best options to seize opportunities proactively and which ones to reallocate resources away from the big threats?

A second aspect is associated with culture, which is considered critical in the digital transformation process by facilitating the development of skills related to speed, flexibility, open innovation, and learning based on the lean start-up model (Ries, 2011, as cited in Lorenzo, 2016, p. 578). Digital culture is defined by (Lorenzo, 2016) as the set of behaviors and habits developed and applied by managers and employees of an organization to make the most of the potential of new technologies. In this order of ideas, it has been argued that it is the presence of digital technologies that points to the existence of a digital culture, since "it encompasses the artifacts and systems of signification and communication that delimit our contemporary way of life from others" (Uzelac, 2008, p. 11).

A third dimension of the model points to the development of a set of practices related to processes, structure, and talent, mainly at the level of middle managers, 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) translate business needs into digital language; (2) develop insights leveraging new data sources and quality algorithms; and (3) verify that future data requirements are adequate and complete (Catlin et al., 2015). The capabilities indicated in the Table 3 being characterized as critical.

Table 3

Critical capabilities that must be developed according to the Digital Quotient Model

Capabilities	Description
Data Driven Decision Making	Change in decision-making processes, from models where a manager bases his decisions on experience towards 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 associated with the platforms designed to deliver rapid results to customers and the identified opportunities and the second associated with the technologies already implemented to optimize the organization's traditional and back-office operations

Note: Adapted from Lorenzo (2016, p. 574)

Subsequently, to help telecommunications service provider organizations, understand their digital maturity at a given moment and support them in the development of a vision and a path for digital transformation, Valdez-de-León (2016) designed a digital maturity model with a focus more like 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 you 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 a more digitized, automated, and flexible operation.
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: Adapted from Valdez-de-Leon (2016)

In this model, Valdez-de-Leon (2016, p. 23) 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 meaning:

- Level 0: Not started / Not started: The organization has not taken any steps to transform itself.
- Level 1: Initiating / initiating: The organization has decided to move towards a digital business and is taking the first steps in that direction.
- Level 2: Enabling / Enabling: the organization is implementing initiatives within the dimension that will form the basis of its digital business.
- Level 3: Integration / Integrating: the initiatives of the organization are integrated throughout the organization to support the capabilities from one end to another.
- Level 4: Optimization / Optimizing: The organization's digital initiatives within the dimension are being adjusted and used to further increase overall performance.
- Level 5: Pioneering / 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 in this case as a diagnostic tool on the vision, the context, and the challenges that the organization faces 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 educational solutions in the digital environment for some time, they have not yet achieved digital transformation. According to Bygstad et al. (2022) this was since 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 capabilities. transformational, which in turn would explain the existence of multiple

visions of maturity of the 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 of them.

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

Table 5
Maturity levels of the digital transformation process

Maturity level	Description
Unrated	The university lacks defined objectives and DT 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 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 the execution of discrete digital initiatives to solve isolated business problems and allocates financial resources for their execution. However, his worldview remains unchanged. Likewise, some internal initiatives of digital products and services are identified that have been successful in the past and that 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 DT 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 the transition to the new DT paradigm in a successful manner. The university's business model has been modernized, focused on the user, and 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 and disruptive using technology and new business models. He flows naturally in the new digital paradigm and is always evaluating 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, n/p)

The authors approach the process of digital transformation of universities from three main perspectives: organizational, sociocultural and technological, and based on the postulates of Chanias and Hess (2016, cited in Castro et al., 2022) identify the five aspects 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 the client, and (5) use and development of information technologies.

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 the digital transformation model of universities.

Table 6
Contributions of the literature considered for the construction of the Digital Transformation Model of 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.

Note: prepared by the author based on the results of the literature review

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 implicit aspects in said process, as mentioned by Castro et al. (2022).

According to the literature consulted, Table 7 shows the dimensions that will make up the preliminary structure of the digital transformation model of universities.

Table 7

Preliminary structure of the digital transformation model of universities

Theoretical Support	**Dimension**	**Description**
Catlin et al.(2015)	Key Capabilities and Resources	It 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 & 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 term. 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 student's 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 student.
	Processes	Transform teaching for digital education. Transforming the teaching and learning dynamics.
Gobble (2018)	Organization and Structure	Way of organizing functions within the University. Roles and responsibilities, talent and learning, form of governance, IT leadership, way of designing work and adapting it through ICTs.
Furedi (2011)	Points of contact with the student	Students need to be assisted at any time, from anywhere and on any device. Service points must be digitized.
Salinas & Vio (2011)	Flexible and personalized teaching	From a one-size-fits-all teaching to a tailor-made teaching. Managing individualized student information through predictive data analysis to offer individualized counseling systems.
Sánchez & Fernández (2010)	Social Networks and Profile Research.	It involves educational marketing. Recruitment of new students. Analyze Click-through rate, which is a digital marketing measure to evaluate the performance of content on the Internet, whether on Google or social media. Understand the perception of our public regarding the academic programs of my university, identify points improvement in the service and to create new programs to respond to the 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.

Note: prepared by the author based on the results of the literature review

As can be seen in Table 7, the structural basis for the creation of the digital transformation model for universities is based on the models of Valdez-de-Leon (2016) and McKensey (Catlin et al., 2015), as well as in the contributions of Crespo and Pariente (2018); Gobble (2018); Furedi (2011); Salinas y Vio (2011); and Sánchez & 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 of the dimensions proposed in the construct reaches its highest level (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.

Dimensions	Factors
1. Institutional Strategic Framework focused on digital transformation.	• Mission and Vision, focused 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 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 present in organizational processes. • Digitized administrative processes. • Digital technologies in workflows. • Organizational structure adaptable to digital. • Decision making incorporating 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's 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 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. • 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 student	• 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 student perceptions in RRSS. • Identification of points of improvement in digital services. • Recruitment of potential students through RRSS. • Promotion of collaborative learning in RRSS.
10. Processes of transformation of teaching for higher education	• Application of ICTs in the teaching-learning process. • Training in digital pedagogical strategies. • Integration student life project - teaching strategy. • Incorporation of digital teaching strategies in pursuit of family integration • Integration of the socioeconomic level of the student with digital teaching strategies.
11. IT investment	• Investment in learning platforms. • Quality technical support in digital processes. • Automation of teaching services aimed at their students. • Investment in administrative technology platforms. • Improvement of contact points with students through ICTs.

Note: prepared by the author based on the results of the literature review

In summary, from the review of the theoretical aspects that feed the design of the digital transformation model of 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. involved in the university context and that considers the organizational, socio-cultural, and technological aspects, in perfect 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 satisfy the 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 allows to successfully face the challenges that arise from a process of digital transformation at the Autonomous University of Chile will depend fundamentally on perceptions of the students regarding each one of the implicit factors in said 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 to design a digital transformation model consistent with the idiosyncrasies and cultural values of the University, so they should also have been considered to carry out this investigation. 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 nature of the data to be collected, and given the exploratory level of the research, for the selection of the sample, non-probabilistic techniques (convenience

sampling) were used based on the approaches of Denzin and Lincoln (2000) being constituted as indicated in Table 9.

Table 9
Sample composition

Sample description	Sample size	Distribution by gender	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

To select the students who participated in the study, pragmatic criteria were used based on the opportunity that was presented to the researchers to obtain the data, always highlighting the voluntary nature of the 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

To collect student data a preliminary model composed of 11 dimensions and 55 underlying factors was created 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 consulted was provided with a questionnaire that indicated the dimensions and preliminary factors linked to the construct, together with the assessment criteria, so that they indicated the degree of importance of each item of the instrument. To do this, they had three response options: 'essential', 'useful but not essential' or 'not essential'. With these 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.

As a result of this process, it was determined that the nine proposed dimensions were validated by obtaining a global validity of 0.661. Regarding the implicit factors in the dimensions, only one of them 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).

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 Global Validity of the Instrument

$$CVR = \frac{n_e - \frac{N}{2}}{\frac{N}{2}} \qquad CVR' = \frac{CVR + 1}{2} \qquad CVI = \frac{\sum_{i=1}^{M} CVRi}{M}$$

n_e = Total experts who consider the item as "essential"	CVR = Content Validity Ratio for each item	CVR_i = Content Validity Ratio of the accepted items
N = Total experts who answered the instrument		M = Total items accepted in the instrument

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 was intended to collect the general data of the respondent (gender, academic level, and disciplinary area to which it belongs).
- In the second section, they were shown the eleven dimensions of the preliminary theoretical model, with their respective definitions, so that they could indicate, using a Likert scale with five response options, the degree of importance they attributed to each dimension. Response options were: "Not important", "Unimportant", "Neutral", "Important", and "Very important", which were later translated into quantitative values, being (1) the one that corresponded to the option "Not important" and (5) to the option "Very important".
- In the third section, they were shown a set of 54 factors related to each of the dimensions listed in the previous section, for them to indicate their assessment of the 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; "Strongly disagree", "Disagree", "Neither agree nor disagree", "Agree", and "Strongly agree", and maintaining the same conversion system to quantitative data, for processing using statistical techniques.

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) that contained 10 questions that had to be answered openly by the interviewees. This protocol was only used as a guide for the researchers, so there was the possibility of asking other questions that were related to the accounts of the interviewees. All were carried out face to face in the context 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 applied to the students were processed using measures of central tendency. To do this, firstly, the relative weight of each of the dimensions of the model was determined, 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 contained in the third section. After obtaining the average valuation of 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. In this way it was possible to determine the assessment that the students assigned to 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 the support of the Atlas.ti software, which facilitated the preparation of analytical memos in which the most important aspects were highlighted. interest obtained from each interview. In this phase, a global idea of the data was obtained and ended with a broad description of each of the categories analyzed. Subsequently, in a second phase, the data obtained in the previous phase were 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 of them. Finally, in a 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

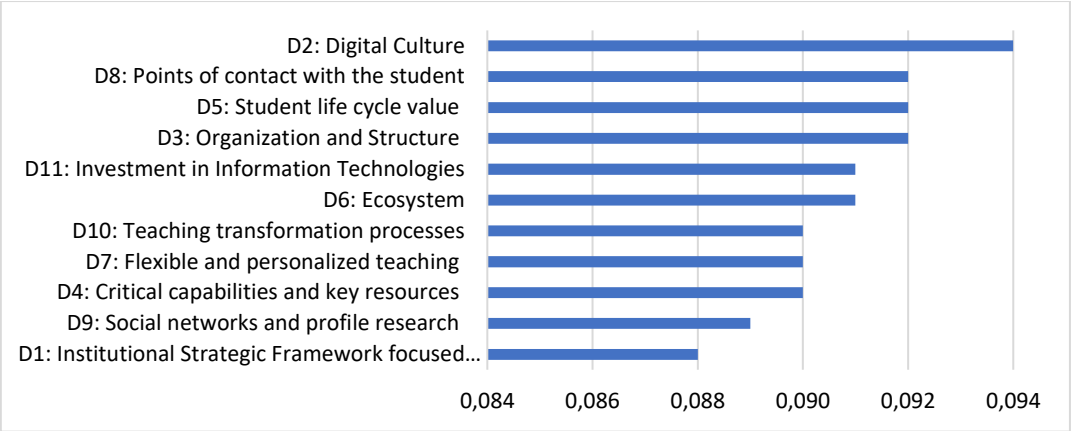
This section shows the results obtained during the data collection process that allowed structuring the theoretical model of the digital transformation process of a University. The section is divided into three sections: (1) quantitative results; (2) qualitative results; and (3) description of the model.

4.1. Quantitative results

The quantitative results shown below derive from the analysis of the data collected through the application of the questionnaire addressed to 97 undergraduate students (55 men and 42 women), students of the Administration and Economics curricular programs (73.2%), Engineering (24.7%) and other careers (2.0%) at the Autonomous University of Chile, obtaining a reliability coefficient (Cronbach's Alpha) 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 (Figure 1), understanding said transformation as the management process that guides the culture, the strategy, the methodologies, and capacities of an organization from the use of digital technologies (Crespo & Pariente, 2018).

Fig. 1 Implicit dimensions in the DT process of a university, and importance attributed to each of them.



In view of the results shown in the previous table and even though the difference between the dimensions that obtained the extreme evaluations is barely 0.005 points, it is striking that the dimension 'Institutional Strategic Framework' has been considered the least relevant in the process of digital transformation in university contexts, understanding that such appreciation is the product of the approach that is typical of the academic profile of the population surveyed. The factors associated with each of these dimensions are shown in Table 11.

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, focused 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, anytime	4,629	0,426	1,939
Solving problems for students, with an IT approach	4,495	0,405	1,840
Technologies in 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 search 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]			
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 student's 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 student [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 student perceptions in RRSS	4,351	0,389	1,768
Promotion of collaborative learning in RRSS	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 ICTs in the teaching-learning process	4,515	0,405	1,840
Training in digital pedagogical strategies	4,515	0,405	1,840
Integration of the student's socioeconomic level with digital teaching strategies	4,505	0,404	1,835
Integration 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 Technologies [0,091]			
Investment in learning platforms	4,577	0,418	1,900
Quality technical support in digital processes	4,557	0,416	1,892
Improvement of contact points with students through ICTs	4,505	0,411	1,870
Investment in administrative technology platforms	4,485	0,409	1,862
Automation of teaching services aimed at your students	4,454	0,407	1,849

Note 1: Data obtained from the questionnaire applied to students.

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

Analyzing the data contained in the previous table, the three main factors involved in the digital transformation process of a university and, therefore, in determining its degree of digital maturity belong to the dimension: "Digital culture", being in order of importance the following:

- 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 process of a university belong to the dimension: "Social networks and profile research" being, in descending order, those indicated below:

- Analysis of student perceptions in RR.SS. (1.77%)
- Promotion of collaborative learning in RR.SS. (1.77%)
- Recruitment of potential students through the RR.SS.(1.76%)

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

4.2. Qualitative results

The main results obtained after processing the information obtained through the interviews carried out with the eight experts consulted are shown below. The codes shown in brackets refer to the codes assigned to each of the interviewees.

In the first place, there is a clear tendency to point to the 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 has been insistently stated that the priority areas of digitalization are associated, precisely, with the possibility that students receive 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 is 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]; In this way, 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 is a product that reflects the institutional culture, its strategic vision and the 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-learning

processes [M1, M6], while the digitization of internal processes finds justification when it facilitates the exchange of timely and reliable information [M3].

It has also been 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.

Along the same lines, 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 a student 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 only.

Apart from the effects derived from the pandemic in terms of the implementation of accelerated digitization processes in fundamental academic areas [M1, M3], and having warned that digitization should not be understood as the solution to problems [M2], Interviewees consider that the main drivers of digital transformation in universities are: (1) corporate purposes (vision, mission, strategic objectives), encompassed in culture and organizational strategy [M5], including the desire to stay ahead the vanguard of knowledge and technology [M7]; (2) commitment to change processes, which is achieved with 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]; (4) and effective communication that allows managing the technological base and decision-making [M2], understanding that communicative interactions intervene as one of the factors that 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 previously transforming people's talent so that they are clear about the approach strategic in terms of what you want to keep and what you want to change [M5].

From another perspective, it has been 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 make it possible to measure the degree of progress in the transformation process, based on the objectives that are expected to be achieved (Figure 2).

It has also been 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 the interviewee [M4], not being considered significant for the design of the digital transformation model.

Fig. 2 Phases of the digital transformation process in a university

Note: Based on the qualitative analysis of interviews conducted with experts

However, just 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 a cultural and financial nature 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 should be added the type of technology that is being used [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 launched about the way in which new technologies are being used, pointing out that their full potential has not yet been recognized [M5].

Returning to 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 the reason why it has been pointed out that 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 about the need for digitization [M3], which is closely linked to the culture of the organization.

It has also been 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. risks that would lead to a potential 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 (rectorship and vice-rectorships) and in charge of a planning area, innovation and development [M2, M3] from which it can expand to the various functional areas to structure a work team that assumes responsibility for the transformation [M5]. In this sense, 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, promote innovation [M7] and integrate digital technologies in the various areas of the university [M7].

Even so and 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 warned, pointing out the advisability of carrying out pilot transformation projects aimed at obtaining small changes that serve to leverage other larger ones [M6]. In this way, is highlighted the importance of permanent learning [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].

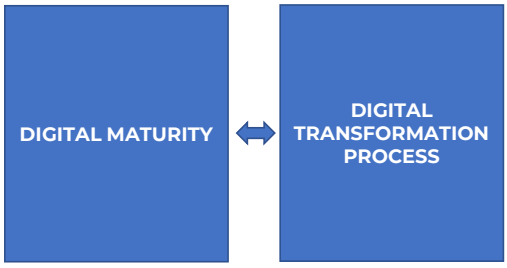
The above remarks allow us to highlight three issues that seem to be fundamental in the digital transformation processes; (1), the set of cultural aspects that characterize the University, from which the strategic decisions on the technological base and the financial resources necessary for the digital transformation emerge; (2) the focus on the student 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 that are possessed 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 shown in the previous section show the structural components of the digital transformation process of a university, which are described below:

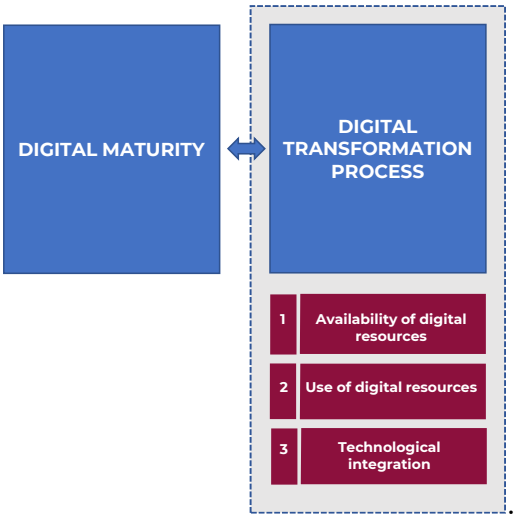
In the first place, it is based on the premise that any process aimed at the digital transformation of higher education institutions is consistent with the degree of digital maturity that it has reached. This means that there is a close and unequivocal relationship between "digital transformation" understood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

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



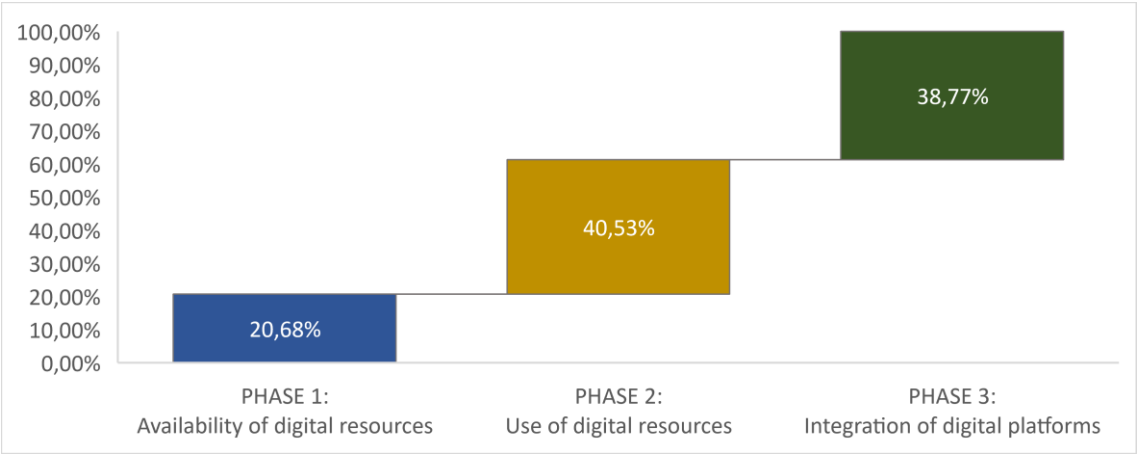
The digital transformation process is made up of three phases that represent a continuum, since the variations in the current situation will occur gradually as actions tending to increase the degree of digital maturity are carried out. As reflected in Figure 4, the three phases of the digital transformation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

Fig. 4 Phases of the digital transformation process of a university



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

Fig. 5 Percentage contribution of each phase of the DT process to the digital maturity of a university



Note: Analysis of data obtained from the questionnaire applied to students

The previous figure shows that the greatest contribution to the digital maturity of a university does not come from the financial resources that are possessed or the

technological base that is available, but from the way of using the available technological resources and, subsequently, from the capacities to manage the integration of the various technologies. Each phase implies the dimensions shown in Table 12.

Considering the three phases that, according to the experts consulted, the digital transformation process of a university goes through, the 11 initial dimensions were reduced to nine dimensions, which were associated with each of these phases (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 (paragraphs 5.1; 5.2 and 5.3).

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

Phases	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 student. 2.2. Teaching-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

It is obvious that any digital transformation process implies the review and adaptation of the technical context that will make possible the claim to 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 spheres of influence are observed that feed the first phase of the process: strategy and culture, financial resources and technological base, the latter referring to equipment, infrastructure, connectivity, and technical support. This phase is consubstantiated with the strategic approach and the organizational culture, its fundamental elements being strategy and culture, financial resources, and the technological base.

5.1.1. Dimension Strategy and Culture

Culture represents the strategic basis for the digital transformation of universities, being related to the interactions between people and technologies to satisfy the requirements of people and society. In this sense, 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 statement, focused on the digital context.
- Formulation of strategic objectives focused on information technologies.
- 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 student experience, and 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 descriptive purposes of the theoretical model of digital transformation of a university, the technological base 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 by using different technologies. The technological base is represented by the following components:

- Availability of 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 prior recognition of the potential of new technologies to then generate and implement initiatives that favor the student experience, facilitate the management of internal processes, and increase competitiveness indices. This phase is consubstantiated with the use and exploitation of the technological base, being its fundamental elements: the focus on the student experience, the improvement of the teaching-learning processes and the use of technological capacities for the greater effectiveness of the processes. economic-administrative.

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 student 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 focus of digitization is none other than student satisfaction, and this premise must be internalized in decision-making processes. The following indicators correspond to this dimension:

- 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 anytime
- Digitization of the student life cycle
- Incorporation of IT for student satisfaction and retention
- Incorporation of IT for continuity of studies

- Integration student life project - teaching strategy
- Improvement of contact points with students through ICTs.

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
- Academic and pedagogical support with a focus on 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 ICTs 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 technologies, which contribute to achieving strategic objectives. The indicators associated with IT governance are:

- Analysis of student perceptions in RRSS
- 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, decision making and focus on customer experience. student. 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 in RRSS

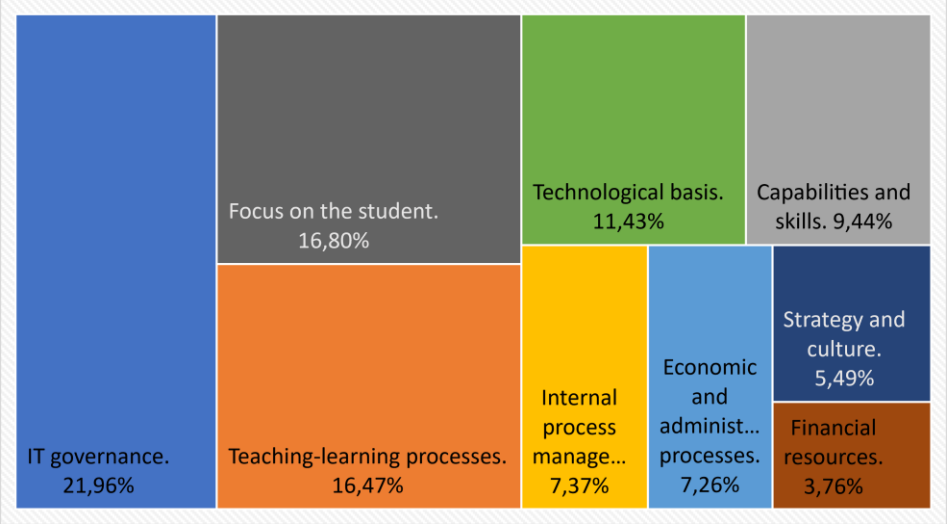
5.3.3. Dimension: Internal process management

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 decision-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 incorporating IT.
- Data-driven decision making

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

Fig. 6 Dimensions of the digital transformation process and percentage contribution 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 the following table (Table 13), indicating their percentage contribution to measuring the degree of digital maturity achieved.

Table 13

Matrix of indicators of the Digital Transformation (DT) process of a university and weighted weight that should be used to determine the degree of digital maturity.

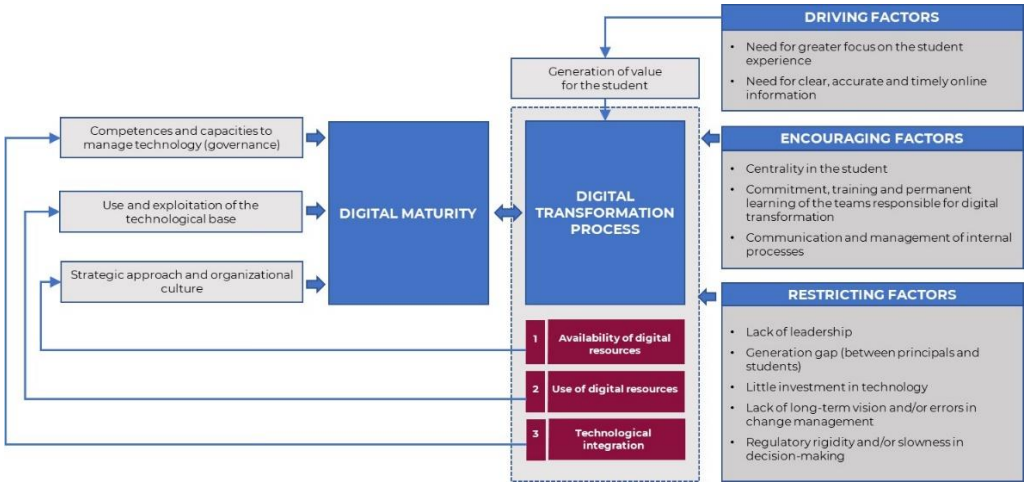
Phases of DT Process	Dimensions	Indicators	Weighted weight
1. Availability of digital resources (20,68%)	1.1. Strategy and culture (5,49%)	Organizational structure adaptable to digital	0,0191
		Strategic objectives with a focus on information technologies	0,0180
		Mission and Vision, focused on digital	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
		Digitized library	0,0190
		Quality technical support in digital processes	0,0189
		Digital technologies present in organizational processes	0,0187
2. Use of digital resources (40,53%)	2.1. Focus on the student (16,8%)	Comprehensive approach to the student experience	0,0194
		Accessible services anywhere, anytime	0,0194
		Incorporation of IT for continuity of studies	0,0188
		Improvement of contact points with students through ICTs	0,0187
		IT Incorporation for Student Satisfaction and Retention	0,0186
		Solving problems for students, with an IT approach	0,0184

		Digitization of the student life cycle	0,0184
		Integration student life project - teaching strategy	0,0183
		IT focus on student loyalty and university brand	0,0180
	2.2. Teaching-learning processes (16,47%)	Academic and pedagogical support with a focus on IT	0,0189
		Labor practices and job search with a digital approach	0,0187
		Application of ICTs in the teaching-learning process	0,0184
		Individualized counseling system	0,0182
		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 teaching model to profile of each student	0,0180
	2.3. Economic-administrative processes (7,26%)	Digitized administrative processes	0,0188
		Integration of the student's 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
		Relationships with Foundations/NGOs	0,0178
		Analysis of student perceptions in RRSS	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 in RRSS	0,0177
	3.3. Internal process management (7,37 %)	Decision making incorporating 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 1: Data obtained from the questionnaire applied to students.

As a synthesis, the theoretical model of the digital transformation process of a university is shown in Figure 7, and it can be seen that the foundation of said process is none other than generating greater value for the student, since, as was As indicated by the experts consulted, no digitalization effort would make sense if it is not focused on the student's experience and the need to have clear, precise and timely information.

Fig. 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 clear relationship between the close relationship between digital maturity and the generation of value for the student through the teaching-learning processes and the economic-administrative processes stands out, which is 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, determinants of the success of the university's digital transformation process, 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 processes that are carried out in the institution.

The foregoing seems to be condensed in what was indicated by Pelletier and Hutt (2021) when they define digital transformation as: "a series of deep and coordinated culture, workforce, and technology shifts that enable new educational and operating models and transform an institution's business model, strategic directions, and value proposition" (p. 30), which implies the need for innovative leadership at all levels of the institution, as well as coordination between the different units. In this regard and in light of the findings of this research, the wide and relevant range of impacts of technological change in higher education institutions is notorious, particularly in the categories of values and operations, as revealed by Núñez et al. (2021) making express reference to the case of Chilean universities.

In this sense, any effort to change towards the digitization of university systems and processes implies that the university model to which one aspires to reach is previously recognized; of course, within a digital logic and in harmony with the social mission of the

university. This will not only give a boost to 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 gradual incorporation of technologies in academic-administrative processes, face the challenges posed by digitalization and consolidate regional, national and supranational alliances that serve as a support to initiate other disruptive processes that, consciously, allow anticipating the new scenarios that derive of scientific-technological advances in the global context.

Hence, the financial difficulties that a university may be going through, its cultural tradition, regulatory rigidity, the absence of a clear vision of what is intended 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 changes in technological matters, 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) has highlighted when he argues that digitalization, as perceived by universities in China and other countries, seems to be oriented towards the instrumental creation of digital campuses and the development of innovations in academic processes, but lack 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 consulted mentioned the improvement of scientific activity, understood as one of the substantive activities of the 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, said transformation process seems to be delimited to the internal context of the institutions.

In this sense, in the field of IT governance, as a 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 allows aligning 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 would give rise to future studies that try to elucidate what are the potential problems and the needs that arise in terms of the new technological interactions that will take place within the University, as well as the identification of the new opportunities offered by such links in the context of university 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 the way of using the available technological resources and by the capacities that it must integrate the different technologies.
3. IT governance, with 21.96%, is the dimension that contributes the most to achieving the digital maturity of the University. Curiously, investment in

administrative and learning technology platforms only contributes 3.76% of the digital maturity that is 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) the focus on the student; (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 at the University are: (1) lack of leadership and little long-term vision; (2) slowness in decision-making processes; (3) 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, suggesting for this the modeling of structural equations. In any case, 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 et al. (2018).

Additionally, considering the reported findings, new questions arise that deserve to be answered from a scientific perspective. For example, an area of possible research would be to analyze the influence of organizational routines in the adoption of an organizational 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 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 process towards digital transformation, since this will affect coordination of internal processes associated with information governance, the ways of acting of people with technical and management responsibilities, the performance of teachers and the confidence of students about future academic and administrative processes.

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Conflicts of Interest Statement
Authors declare no conflict of interest.

Institutional Review Board Statement
The research protocol and data collection instruments were approved on October 3, 2022, by the Research Group for Sustainable Organizational Studies (GIEOS), of the Autonomous University of Chile.

Data Availability Statement
The questionnaire applied to the students and the data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy restrictions.

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APPENDIX I

INTERVIEW PROTOCOL

1. In your opinion, which are the area's 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 produce a greater impact on student satisfaction when digitized? Could you briefly describe the impact it would produce?
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 towards 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 comment or reflection on the possible impact of digital transformation on Chilean universities?

ARTÍCULO 3

Validation of the digital transformation model of the Autonomous University of Chile

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Validation of the digital transformation model of the Autonomous University of Chile

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Abstract—The emergence and massification of digital technologies are having such an impact on educational systems that universities are being forced to design transformation processes that make it possible to ensure the gradual incorporation of technologies into academic-administrative processes with a view to achieving greater student-centered educational quality. In response to this need, and for the specific case of the Autonomous University of Chile, a digital transformation model composed of nine dimensions and 54 indicators was designed, which was subjected to an analysis process through structural equation modeling to check its consistency, reliability, and validity. With data resulting from the application of surveys to 97 undergraduate students from that university, it was possible to demonstrate that the variables considered, and their corresponding dimensions form a solid construct that can explain the preliminary model of the digital transformation process of the university. Therefore, even recognizing limitations of a methodological nature, the model was intrinsically validated by the data. The findings represent a first approximation for the construction of a new academic-administrative scenario at the Autonomous University of Chile, which is based on the proper use of scientific-technological advances that have occurred in the global context.

Keywords—digital transformation, higher education, factor analysis, structural equations

1. Introduction

The emergence of digital technologies and the widespread use of them represents a milestone in the socioeconomic evolution of humanity. The paradigm of the digital age, whose beginnings date back to 2002 when the information accumulated in technological tools exceeded the volume of analog information [1], produced a digital divide that is becoming less and less if the global context is considered [2]. However, this new paradigm, which began with the proliferation of data communication and storage, has entered a new stage in which algorithms create automated processes that make it easier to turn information into actionable knowledge.

This technological scenario has had such an impact on educational systems that Facer and Selwyn [3] went so far as to affirm that digital technologies are an increasingly prominent feature of the provision and practice of contemporary education throughout the world and are fundamental to building the social imaginary about the future of education, which is significantly related to innovation and its contribution to socioeconomic development [4]. This, coupled with the fact that the educational importance of digital technologies has been amplified during the Covid-19 pandemic due to the massive adoption of digital educational resources, has sown hope, albeit cautiously, about the possibility of a profound transformation of education.

Educational structures are moving towards technological devices [5], however, it is known that digital technology by itself does not transform education; In fact, despite the increasing visibility of digital devices and online systems, the essence of educational processes seems to remain intact in the absence of substantial changes that could favorably impact training and the student experience. It has also been argued that even though there are many theoretical explanations for the potential learning benefits arising from the use of digital technologies, there is still little solid evidence to validate these claims, and, in any case, the findings are still inconclusive. On the other hand, the reduction of social inequalities using digital resources in education is still a great ambition, having argued that "the use of technology in education continues to be subject to and often reproduces a series of persistent and pernicious inequalities" [3] (p.7)

The previous elements of judgment point to the need to consider that any impact that arises after the introduction of these technologies in educational systems is specific to a certain context and is closely related to sociotechnical factors that show the multidimensionality of the educational phenomenon in the digital age. Consequently, any attempt to take advantage of digital technologies and generate greater value for the student through the teaching-learning processes and the economic-administrative processes must consider the characteristics of the system in which the educational event occurs. especially in three closely related aspects: (1) strategic focus and organizational culture; (2) the way to use and take advantage of the available technological base; and (3) the skills and abilities that are possessed to manage the technology, as emerged from a study carried out by the author, in the year 2022, at the Autonomous University of Chile (UAM).

Based on the above, and assuming that the student should be the center of attention in the decision-making process, a preliminary theoretical model was developed for the digital transformation of that University, in order to direct the mechanisms to ensure a process of transformation that takes into account the digital skills (current and desired) of students, teachers and those responsible for managing the gradual incorporation of technologies in academic-administrative processes and that, in addition, allow anticipating the new scenarios that derive of 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 sense and because it is a preliminary theoretical model, the purpose of this study was to empirically validate said construct by subjecting it to a process of analysis through which its consistency could be evaluated with respect to other previously established knowledge and theories, identify and correct errors or weaknesses, improve their accuracy, ensure their usefulness and reliability to make informed decisions, make accurate predictions and verify underlying hypotheses.

2. Conceptual framework of the research

In the last ten years, the idea of digital transformation has gained traction in the management literature. This concept has transcended the simple fact of measuring how an organization can benefit from the use of information technology, to conceive it as an evolutionary process in which said technology becomes an essential element in the daily life of the organization, affecting all dimensions of it, including workers and users. In other words, digital transformation refers to the changes caused by digital technologies that influence various aspects of human life [6].

There is no single interpretation of what digital transformation means. Some authors conceive digital transformation as an incremental application of information technology to business processes [7]. Other theorists consider that this type of transformation represents an abrupt and disruptive change that can reach to generate chaos in the business world [8]. A less radical definition implies that digital transformation is a progressive process that takes advantage of digital capabilities and technologies to enable new business models and operational processes that impact the consumer experience by generating more value [9]. Digital transformation can also be viewed from the perspective of changes in structure, strategy, and technology; these dimensions, that interact to respond to the needs imposed by the dynamics that are typical of digital environments [10], requires the proper implementation of digital skills, which represent the core of professional training and lifelong learning, being essential to improve personal performance, active citizenship, social inclusion and employability [11].

Although it is true that the concept of digital transformation is not new, its considerable relevance in the contemporary context has been driven by the rapid evolution of technology and the massification of telecommunications networks, which has allowed the emergence of new practices and management models that have changed the way people and companies interact [12]. It has even been argued that, in the educational context, the digital transformation of higher education "determines the future roadmap towards a sustainable education management strategy" [13] (p. 3171).

The foregoing is consistent with the general perception that one of the great urgent problems posed by education today is, precisely, the modernization of the system, which must adapt to the requirements imposed by the digital economy, which raises the need to create mechanisms that enable digital transformation [14]. To make this task possible, different approaches have been proposed whose

dimensions reveal a fragmented image, but which, in any case, according to Teichert [15] reveals the impact of culture on transformational capacities; deducing that the success of any digital transformation process must consider the cultural particularities of the context in which it will take place.

In the case of this research, the dimensions of the digital transformation model to be validated arose because of operationalizing a solid theoretical body represented by the contributions of Catlin, Scanlan & Willmontt [16], Westerman, Bonnet, & McAfee [17] and Valdez-de-León [18], to which were added the contributions of Crespo & Pariente [19], Furedi [20], Gobble [21], Salinas & Vio [22] and Sánchez & Fernández [23]. The model is based on the premise that the maturity of any university's strategic processes can be achieved if most of the factors of each dimension are met; that is, if the level of digitization of each of the dimensions proposed in the construct reaches its highest level [24]. Each of the theoretical contributions that were considered to design the digital transformation model of the Autonomous University of Chile is described below.

Starting with Catlin, Scalan & Willmontt [16] these authors base their proposal on the McKinsey model, presenting a set of dimensions and factors to measure the digital maturity of a company and which they called the 'Digital Quotient Model'. In this model, the starting point is the definition of a clear and precise digital strategy, which is integrated into the company's corporate strategy and whose alignment is key to the success of the digital transformation. According to the authors, designing a correct digital strategy involves answering three key questions: where are the most relevant opportunities and threats? How fast and at what scale could a digital disruption occur in my sector? And what are the best options to seize opportunities proactively and which ones to reallocate resources away from the big threats?

In summary, the dimensions and factors that are integrated into the digital quotient model are:

- Strategy: bold, long-term orientation, digital strategy linked to business strategy and focused on customer needs.
- Culture: risk appetite, speed and agility, ability to learn from mistakes, internal collaboration, and external orientation.
- Organization: roles and responsibilities, talent and learning management, governance and performance indicators, investment in digital technologies.
- Capabilities: connectivity, focus on customer experience, decision-making based on data, automation, and information technology architecture.

Another theoretical root that was used for the design of the theoretical model of digital transformation of the University corresponds to the proposal presented by Valdez-de-León [18] who designed a model of digital maturity with an approach more like the function of universities, understood as service provider organizations. The model presents the dimensions and factors indicated below:

- Strategy: vision, governance, planning and management of the processes that will support the execution of the digital strategy.
- Organization: changes in culture, structure, training, and knowledge management
- Customer: new benefits created in the customer experience through digital changes in their journeys.
- Ecosystem: development and support of ecosystems of partners and allies, which are conceived as fundamental elements in any digital business.
- Operations: more digitized, automated, and flexible, which contribute to reaching a higher level of digital maturity based on the capabilities that support the provision of services.
- Technology: Effective technology planning, including deployment, integration, and its use to support digital business.
- Innovation: New flexible and agile ways of working that will form the basis for an effective digital business.

A third theoretical contribution that was key to the design of the digital transformation model of the University corresponds to the Digital Maturity Model (IMD) proposed by Westerman, Bonnet and McAfee [17], who after demonstrating the existence of a significant correlation between digitization and competitiveness, designed a model through which any organization could gradually and progressively develop its key capabilities that would allow it to evolve and be successful in the new digital age.

In that model, the authors combined two closely related aspects that could describe how companies are reacting to digital opportunities:

- Digital intensity, or the level of investment in technology initiatives aimed at changing the way the company operates.

- Transformation management intensity, understood as 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 change based in the technology.

As a synthesis, the theoretical contributions that defined the preliminary structure of the Digital Transformation Model of the University that was submitted to empirical validation, were those indicated in table 1.

Table 1. Theoretical contributions considered to design the preliminary structure of the digital transformation model of the Autonomous University of Chile.

Theoretical Support	Dimension	Description
Catlin, Scanlan & Willmott [16]	Key Capabilities and Resources	It 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 & Pariente [19]	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 term. It involves adapting the corporate, business, and functional strategy to a digital modality.
Valdez-de-León [18]	Student life cycle	New benefits created in the student experience thanks to digital transformation. It involves the student's 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 student.
	Processes	Transform teaching for digital education. Transforming the teaching and learning dynamics.
Gobble [21]	Organization and Structure	Way of organizing functions within the University. Roles and responsibilities, talent and learning, form of governance, IT leadership, way of designing work and adapting it through ICTs.
Furedi [20]	Points of contact with the student	Students need to be assisted at any time, from anywhere and on any device. Service points must be digitized.
Salinas & Vio [22]	Flexible and personalized teaching	From a one-size-fits-all teaching to a tailor-made teaching. Managing individualized student information through predictive data analysis to offer individualized counseling systems.
Sánchez & Fernández [23]	Social Networks and Profile Research.	It involves educational marketing. Recruitment of new students. Analyze Click-through rate, which is a digital marketing measure to evaluate the performance of content on the Internet, whether on Google or social media. Understand the perception of our public regarding the academic programs of my university, identify points improvement in the service and to create new programs to respond to the needs.

Based on the theoretical contributions indicated, the complexity of the aspects that intervene in the digital transformation of the University is observed, which is in harmony with what was argued by Rossman [25] when he warns about the need to develop a set of capabilities linked to different dimensions, including: leadership, market, operations, people, culture, governance and technology; or as Mühlburger et al. [26] points out when relating digital transformation to factors such as organizational values (culture), management capacity, organizational infrastructure and workforce capabilities.

Given these indications, the structure of the digital transformation model of the University was integrated by nine variables and 54 indicators, as observed in Table 2.

Table 4. Variables and indicators of the preliminary theoretical model of digital transformation of the Autonomous University of Chile.

Variables / Description	Indicators
Strategy and culture. Strategic basis for the digital transformation of universities, 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 decisions related to university policies and strategies related to obtaining, using and integrating digital technologies.	Mission and vision statement, focused on the digital context. Formulation of strategic objectives focused on information technologies. Organizational structure adaptable to the demands of the digital environment.
Financial resources.	Investment in learning platforms. Investment in administrative technology platforms

They affect the way in which digital transformation occurs and represent the basis for improving internal processes and productivity, differentiating from the competition by providing a better student experience, and anticipating the trends of the digital age both in terms of learning platforms as administrative.	
Technological basis. It 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.	Availability of 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.
Focus on the student experience. The digital transformation process must be based on the need to increase the centrality of the student 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. This premise must be internalized in the decision-making processes.	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 anytime Digitization of the student life cycle Incorporation of IT for student satisfaction and retention Incorporation of IT for continuity of studies Integration student life project - teaching strategy Improvement of contact points with students through ICTs.
Teaching-learning processes. They 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. In this dimension 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.	Use of predictive data to anticipate student needs. Individualized counseling system Academic and pedagogical support with a focus on 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 ICTs in the teaching-learning process Incorporation of digital teaching strategies in pursuit of family integration
Economic-administrative processes. They 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 by improving response time, and facilitate 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.	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 approach
IT governance. Ability to lead processes aimed at centralizing information to understand and decode it to improve decision-making processes based on data from different sources. From an external perspective, IT governance is related to the management of links with the different entities that make up the university ecosystem. This variable is consubstantiated with the management and control of all processes, mediated by information technologies, which contribute to achieving the strategic objectives of the university.	Analysis of student perceptions in RRSS 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.
Competencies and abilities. Cognitive, emotional, and attitudinal skills required to integrate digital technologies and reduce the technological gap between the people that make up the various levels of the university.	Training focused on digital technologies. Training in digital pedagogical strategies Tolerance to changes Continuous learning ability Promotion of collaborative learning in RRSS
Internal process management. It covers all the processes that must be carried out to achieve the strategic objectives of the university in a context characterized using integrated digital technologies, both to support workflows and for decision-making related to performance improvement and of relations with students, teachers, administrators, and other interest groups.	Digital technologies in workflows Technologies in back-office optimization of the organization Decision making incorporating IT Data-driven decision making

3. Methodology

For the validation of the initial model of digital transformation of the University, a three-step methodology was used that allowed us to obtain a definitive adjusted model, with sufficient reliability to contrast the preliminary hypotheses.

- Development of the data collection instrument (survey) to find out the students' perspective on the degree of importance attributed to the factors involved in the digital transformation process of the university.
- Exploratory Factor Analysis (EFA) using IBM SPSS.
- Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM) to confirm inferred correlations and causal relationships between factors. For this phase, the AMOS extension, v.23 of the SPSS statistical package, was used.

Specifically, the methodological process was carried out, initially, by checking the validity of the constructs through: (1) convergent validation, which allowed evaluating to what extent the selected items were representative to define the latent variables of the model; (2) discriminant validation, which served to verify that the indicators associated with a latent variable were not related to other constructs, and (3) factor analysis, in order to determine how much each factor contributes to defining the construct with which it relates. associated. Subsequently, the structural model was applied, evaluating the goodness of fit from the measures of absolute fit, incremental fit and parsimony, and then validating the relationships between the constructs that were proposed as preliminary hypotheses in the theoretical model of digital transformation, presented in table 2.

The data was collected through surveys that were applied to a group of 97 undergraduate students from the Autonomous University of Chile. Prior to data collection, experts were asked to review the questionnaire for validation purposes. The overall content validity of the instrument was 0.714, using the Lawshe model [27].

Survey results were entered into IBM SPSS and descriptive statistics were used to identify outliers that might result from an error made during data entry.

An exploratory factor analysis was performed to determine the underlying factor structures; that is, to identify the observed variables that were associated with each latent variable.

Then, using the results of the exploratory factor analysis, a confirmatory factor analysis was performed to demonstrate the validity of the factorial structure previously obtained with the EFA and, consequently, confirm the validity of the deductions inferred during the design of the preliminary theoretical model.

The validation of the preliminary digital transformation model of the university was carried out using the structural equation modeling (SEM) technique, which is commonly used in correlational studies in which only the magnitude of the variables is observed. that are not manipulated by the researcher. Structural equation models consist of two fundamental parts: (1) the measurement model, which contains the way in which each latent construct is measured by its observable indicators, the errors that affect the measurements, and the relationships that are expected to be found. between the constructs when they are related to each other; and (2) the model of structural relationships, which contains the effects and relationships between the constructs [28].

For the study, factor analysis was required, which is considered the technique par excellence for the validation of theoretical constructs [29]. It is a statistical model that represents the relationships between a set of variables or items that can be explained from a series of unobservable (latent) variables called factors, which, in number, are substantially less than that of the observable variables [30]. Conceptually, factor analyzes have two modalities: Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA), whose fundamental difference lies in the fact that EFA is a data-based technique that tries to discover the underlying structure that these have by searching for patterns of relationships between the indicators, while the CFA is mainly driven by substantive theories and by expectations, so the contrasting of the structural hypotheses that derive from the theory will be the one that determine the validity of the construct.

In general, Exploratory Factor Analysis refers to a set of multivariate statistical methods of interdependence that have the purpose of identifying a structure of factors underlying a large set of data [31]. Each of these factor's groups interrelated items that, at the same time, are relatively independent from the other sets of items. This interrelation between items is since such variables have something in common and something that differentiates them, so their total variance is due to factors that they share with the other variables (community), but also to factors that are specific to that variable (specificity).

For its part, the Confirmatory Factor Analysis seeks to estimate the correlation between the latent variables and their association with the items [32]; that is, to assess whether the latent variables can be explained by a smaller number of underlying factors. In this way, the preliminary structure of the model is confirmed or rejected by comparing the results obtained from the observed data. In summary, the results of the EFA are useful to define constructs and, consequently, to deduce theoretical models, while the usefulness of the CFA lies in its ability to demonstrate the validity of the construct that has arisen from such deductions.

The statistical tests applied as a step prior to factor analysis were: (1) the Kaiser-Meyer-Olkin (KMO) test, and (2) the Bartlett sphericity test. The KMO test measures the suitability of data for factor analysis in terms of the adequacy of sampling for each variable in the model. The resulting value refers to the proportion of variance in the variables that can be caused by underlying factors. A value less than 0.5 indicates that the results of the factor analysis may not be very useful [33].

For its part, Bartlett's sphericity test allows us to test the hypothesis that the correlation matrix is an identity matrix, which would reflect that the variables are not related and, therefore, are not suitable for the detection of structures. Small values (less than 0.05) of the significance level indicate that factor analysis may be useful with the available data [34].

Sedimentation graphs (Scree Plot) were used to determine the number of factors to be extracted to achieve the most parsimonious factorial structure, in which the factors that explain most of the total variability of the data are reflected.

4. Results

4.1. Exploratory Factor Analysis

The objective of the Exploratory Factor Analysis was to identify the theoretical structure of the data, identifying the dimensions or latent variables that underlie it. As the dimensions of the model were already defined a priori, this analysis had as its purpose the statistical validation of each dimension; that is, verify the internal consistency of each construct.

Each indicator was measured through a five-level Likert scale, where it is desired to know the importance assigned to each indicator in the digital transformation process of the university. The scale goes from least important to most important; the levels are: 1 = “unimportant”, 2 = “scarcely important”, 3 = “neutral”, 4 = “important” and 5 = “very important”.

Because the variables or indicators were measured through a Likert scale, the factorial method was chosen: "Principal Component Analysis" being the rotation method used "Varimax", which rotates the factor axes orthogonally, making that the factors have a 90º angle between them and minimize the number of variables that have high loads on each factor; in this way the interpretation of the factors is simplified [34].

Once the analysis method used has been exposed, the results obtained for each of the phases and dimensions of the model are presented and interpreted below.

Phase 1. Availability of digital resources. This phase is composed of three dimensions: (1) Strategy and Culture, (2) Financial Resources, and (3) Technological Base.

Strategy and Culture. This dimension was measured through the following indicators:

- Organizational structure adaptable to digital
- IT-focused strategic objectives
- Mission and Vision, focused on digital.

Prior to the analysis, it was verified that the data were apt to apply the factorial analysis. For this, the Kaiser-Meyer-Olhin (KMO) tests and the Bartlett's Sphericity Test were used, the results of which are shown in Table 3.

Table 5. KMO and Bartlett's Test – 1.1. Strategy and Culture.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0,681
Bartlett's Test of Sphericity	Approx. Chi-Square	86,412
	df	3
	Sig.	0,000

As can be seen in the previous table, the KMO value is close to 0.7 (required value) and the Bartlett's sphericity test is significant (Chi-square= 86.412 and $p < 0.01$). This indicates that the theoretical assumptions for applying the factor analysis are met.

Subsequently, the Principal Component Analysis (PCA) was applied to extract the most important factors; that is, those that had an eigenvalue greater than or equal to 1, to verify how many factors were required to explain the dimension satisfactorily (Table 4).

Table 6. Total Variance Explained.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	2,109	70,296	70,296	2,109	70,296	70,296
2	0,541	18,034	88,330			
3	0,350	11,670	100,000			

In the previous table it could be seen that a single factor is relevant in this dimension, explaining 70.3% of the total variability. In this way, it is confirmed that the use of a single factor to measure the Strategy and Culture dimension is adequate. The load of each indicator on this factor is presented in the following table (Table 5), and it can be observed that all the indicators that make up this dimension have a similar importance, above or close to 0.8.

Table 7. Component Matrix

Nº	Indicator	Component
		1
1.1.2	IT-focused strategic objectives	0,879
1.1.3	Mission and Vision, focused on digital	0,838
1.1.1.	Organizational structure adaptable to digital	0,796

Financial resources. Exploratory Factor Analysis was not applied to this dimension because it is made up of only two indicators (investment in learning platforms and investment in administrative technology platforms), falling below the minimum of three indicators that is considered adequate for this type of analysis.

Technological Base. This dimension is made up of the following indicators:

- Digital platform for student affairs
- IT support to foster work groups.
- Digital support for the student-director-secretary relationship
- Digitized library
- Quality technical support in digital processes
- Digital technologies present in organizational processes.

The results of the KMO and Bartlett's Test for this dimension are shown in Table 6.

Table 8. KMO and Bartlett's Test - Technological Base.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0,797
Bartlett's Test of Sphericity	Approx. Chi-Square	298,641
	df	15
	Sig.	0,000

The assumptions verification tests to apply the factorial analysis were satisfactory. The KMO = 0.797 (greater than 0.7) and the Bartlett's Sphericity test was significant (Chi-square = 298.641 and $p < 0.01$). Applying the AFE with all the indicators, the following results were obtained. Table 7 shows the total variance explained.

Table 9. Total Variance Explained.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*

1	3,614	60,231	60,231	3,614	60,231	60,231
2	0,893	14,884	75,114			
3	0,618	10,303	85,417			
4	0,425	7,084	92,501			
5	0,278	4,631	97,132			

The first component can be considered relevant to explain this dimension because it explains 60.2% of the total variability. This validates the composition of this factor, being adequate to consider all the indicators as a single dimension. Table 8 shows the coordinates of each indicator in the factor.

Table 10. Component Matrix.

Nº	**Indicator**	**Component**
		1
1.3.1	Digital platform for student affairs	0,892
1.3.2	IT support to foster work groups	0,848
1.3.3	Digital support for the student-director-secretary relationship	0,835
1.3.4	Digitized library	0,831
1.3.6	Digital technologies present in organizational processes	0,642
1.3.5	Quality technical support in digital processes	0,546

In the previous table most of the indicators or variables have a significant and similar load on this factor, except for two variables that turn out to be the least relevant; These are: digital technologies present in organizational processes (0.642) and quality technical support in digital processes (0.546).

Phase 2. Use of Digital Resources. This phase is made up of three dimensions: (1) Focus on the student, (2) Teaching-Learning Processes and (3) Economic-administrative processes. By applying the Exploratory Factor Analysis, the underlying structure of each of them can be explored.

Focus on the student. This latent variable, or dimension, was measured through nine indicators:

- Comprehensive approach to the student experience
- Accessible services anywhere, anytime
- Incorporation of IT for continuity of studies
- Improvement of contact points with students through ICTs
- IT Incorporation for Student Satisfaction and Retention
- Solving problems for students, with an IT approach
- Digitization of the student life cycle
- Integration student life project - teaching strategy
- IT focus on student loyalty and university brand.

Table 9 show the results of KMO and Bartlett's Test

Table 11. KMO and Bartlett's Test – Focus on the student.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0,803
Bartlett's Test of Sphericity	Approx. Chi-Square	86,412
	df	3
	Sig.	0,000

The KMO test is equal to 0.803 and the Bartlett's sphericity test is significant (Chi-square = 86.412; $p < 0.01$), indicating that factor analysis can be applied to explore the data. The first output of the analysis returns the following results. The results shown in table 10.

Table 12. Total Variance Explained.

Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	***% of Variance***	***Cumulative %***	***Total***	***% of Variance***	***Cumulative %***
1	4,807	53,408	53,408	4,807	53,408	53,408
2	1,449	16,096	69,504	1,449	16,096	69,504
3	0,917	10,187	79,692			
4	0,588	6,532	86,224			
5	0,461	5,125	91,348			
6	0,291	3,230	94,578			

7	0,250	2,781	97,359			
8	0,139	1,542	98,901			
9	0,099	1,099	100,000			

According to the results shown in the previous table, the AFE suggests the existence of two factors to explain this dimension, since between them they explain 69.5% of the variability of the dimension. The composition of each factor is shown in Table 11.

Table 13. Component Matrix.

Nº	Indicator	Component	
		1	*2*
2.1.6	Solving problems for students, with an IT approach	0,903	
2.1.9	IT focus on student loyalty and university brand	0,843	
2.1.2	Accessible services anywhere, anytime	0,829	
2.1.8	Integration student life project - teaching strategy	0,634	
2.1.1	Comprehensive approach to the student experience	0,570	0,416
2.1.3	Incorporation of IT for continuity of studies		0,903
2.1.7	Digitization of the student life cycle		0,898
2.1.5	IT Incorporation for Student Satisfaction and Retention		0,847
2.1.4	Improvement of contact points with students through ICTs		0,617

On the first factor, five indicators are important: 2.1.6; 2.1.9; 2.1.2; 2.1.8 and 2.1.1 while the others do it on the second factor. At this point there are two options, the first: use two dimensions with new conceptualizations of each construct, and the second: eliminate some indicators to force the final solution to be reflected in a single factor.

Without underestimating the first option, work began on option two, managing the variables aimed at obtaining a single factor; for this, some variables of the second factor were discarded, starting with the one with the highest factorial coordinate and so on.

After eliminating the indicators: Incorporation of IT for the continuity of studies (2.1.3) and Digitization of the student's life cycle (2.1.7), the results shown in table 12 were obtained.

Table 14. Total Variance Explained.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	3,875	55,355	55,355	3,875	55,355	55,355
2	0,994	14,197	69,551			
3	0,720	10,285	79,836			
4	0,575	8,207	88,043			
5	0,419	5,987	94,030			
6	0,268	3,831	97,862			
7	0,150	2,138	100,000			

When obtaining the solution in a single factor, it is observed that some explained variability is lost, achieving 55.3% of the total variability; however, this proportion is considered "acceptable" since it is greater than 50%. Table 13 shows the final composition of this dimension.

Table 15. Component Matrix

Nº	Indicator	Component
		1
2.1.6	Solving problems for students, with an IT approach	0,880
2.1.2	Accessible services anywhere, anytime	0,817
2.1.9	IT focus on student loyalty and university brand	0,808
2.1.1	Comprehensive approach to the student experience	0,713
2.1.8	Integration student life project - teaching strategy	0,681
2.1.5	IT Incorporation for Student Satisfaction and Retention	0,673
2.1.4	Improvement of contact points with students through ICTs	0,596

In short, there are seven indicators that make up and bear on this factor, with three being the most important: ‘Solving problems for students with an IT approach’ (0.88); Accessible services anywhere, anytime (0.817) and ‘IT focus on student loyalty and university brand’ (0.808).

Teaching-learning processes. This dimension is made up of nine indicators:

- Academic and pedagogical support with a focus on IT
- Labor practices and job search with a digital approach
- Application of ICTs in the teaching-learning process
- Individualized counseling system
- Teaching model appropriate to the physical location of the student
- Use of predictive data to anticipate student needs.
- Incorporation of IT into the student's study rhythm
- Incorporation of digital teaching strategies in pursuit of family integration
- Adaptation of the teaching model to the profile of each student

Table 14 show the results of KMO and Bartlett's Test for dimension: “Teaching-learning processes”.

Table 16. KMO and Bartlett's Test - Teaching-learning processes

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0,846
Bartlett's Test of Sphericity	Approx. Chi-Square	553,845
	df	36
	Sig.	0,000

The result of the KMO test is 0.846 and the Bartlett's sphericity test is significant (Chi-square= 553.845; $p < 0.01$), indicating that the assumptions for applying the factorial analysis are met. The results obtained by Component Analysis are shown in table 15.

Table 17. Total Variance Explained.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	5,109	56,768	56,768	5,109	56,768	56,768
2	1,312	14,577	71,345	1,312	14,577	71,345
3	0,816	9,069	80,415			
4	0,456	5,066	85,481			
5	0,372	4,138	89,619			
6	0,324	3,596	93,215			
7	0,244	2,716	95,931			
8	0,194	2,153	98,084			
9	0,172	1,916	100,000			

The solution yields two factors that explain 71.35% of the total variability. This suggests that such indicators are better represented by two dimensions or latent variables.

In a similar way to what happened in the previous dimension, a new dimension can be included in the analysis, but several indicators can also be excluded until obtaining a single dimension. Table 16 shows the structure of each factor.

Table 18. Component Matrix.

Nº	Indicator	Component	
		1	*2*
2.2.6	Use of predictive data to anticipate student needs	0,847	
2.2.7	Incorporation of IT into the student's study rhythm	0,840	
2.2.4	Individualized counseling system	0,821	
2.2.9	Adaptation of the teaching model to the profile of each student	0,820	
2,2,5	Teaching model appropriate to the physical location of the student	0,796	
2.2.3	Application of ICTs in the teaching-learning process	0,641	0,367
2.2.8	Incorporation of digital teaching strategies in pursuit of family integration	0,555	0,506
2.2.1	Academic and pedagogical support with a focus on IT		0,933
2.2.2	Labor practices and job search with a digital approach		0,877

In this case, it is imperative to find the solution with a single factor because in the second factor only two indicators are significantly loaded, requiring at least three indicators for it to be accepted. Following the previously explained methodology, indicator 2.2.1 was excluded and the solution was obtained with a single factor, which was what was intended. The results obtained by Component Analysis are shown in table 17.

Table 19. Total Variance Explained.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	4,816	60,205	60,205	4,816	60,205	60,205
2	0,864	10,796	71,001			
3	0,759	9,484	80,485			
4	0,451	5,633	86,118			
5	0,365	4,560	90,679			
6	0,319	3,984	94,662			
7	0,233	2,916	97,578			
8	0,194	2,422	100,000			

This factor explains 60.2% of the total variability, which is considered good, although some explained variability is lost with respect to the initial solution; however, all the indicators load on a single factor.

Table 18 shows the composition of the factor; that is, the way in which the variables shape or load on it.

Table 20. Component Matrix

Nº	Indicator	Component
		1
2.2.9	Adaptation of the teaching model to the profile of each student	0,861
2.2.6	Use of predictive data to anticipate student needs	0,852
2.2.5	Teaching model appropriate to the physical location of the student	0,819
2.2.4	Individualized counseling system	0,811
2.2.7	Incorporation of IT into the student's study rhythm	0,806
2.1.5	Application of ICTs in the teaching-learning process	0,742
2.2.8	Incorporation of digital teaching strategies in pursuit of family integration	0,717
2.2.2	Labor practices and job search with a digital approach	0,555

Except for the indicator ‘Labor practices and job search with a digital approach’ (2.2.2), all the variables load significantly and are quite similar. The four main indicators are associated with aspects related to aspects that individualize the teaching process to improve learning, such as the ‘Use of data that allows anticipating the needs of the student’ (2.2.6) or the ‘Adaptation of the teaching model to the profile of each student’ (2.2.9).

Economic-administrative processes. This dimension is made up of four indicators:

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

Table 19 show the results of KMO and Bartlett's Test for this dimension.

Table 21. KMO and Bartlett's Test - Economic-administrative processes.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0,729
Bartlett's Test of Sphericity	Approx. Chi-Square	66,001
	df	6
	Sig.	0,000

As can be seen in the table above, both the KMO test (0.729) and the Bartlett's Sphericity test (Chi-square= 66.0; $p < 0.01$) indicate that the data meet the assumptions to apply the factorial analysis, whose results are shown in the following table (table 20)

Table 22. Total Variance Explained.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	2,117	52,929	52,929	2,117	52,929	52,929
2	0,805	20,122	73,051			
3	0,547	13,682	86,734			
4	0,531	13,266	100,000			

The solution provided by the model is one factor, corroborating that the variables are part of the same construct; the factor explains 52.9% of the total variability. To understand the composition of this factor, Table 21 shows how it loads each variable and its magnitude.

Table 23. Component Matrix.

Nº	Indicator	Component
		1
2.3.4	Recruitment of potential students through social networks	0,789
2.3.3	Student loyalty strategies with a digital focus	0,780
2.3.2	Integration of the student's socioeconomic level with digital teaching strategies	0,735
2.3.1	Digitized administrative processes	0,587

All the variables load positively and with similar magnitudes, except the indicator 'Digitized administrative processes' (2.3.1), which is less important in the conformation of the factor (0.587).

Phase 3. Integration of Technological Platforms. This last phase integrates the following dimensions: (1) IT Governance; (2) Competences and capacities, and (3) Management of internal processes. Next, the results for each dimension can be visualized, using the Principal Component Analysis (PCA) as a means of exploring the underlying relationships in each one of them.

IT Governance. This dimension was measured by 12 indicators:

- Promotion of projects on digital issues
- Relations with international universities
- Relations with companies and corporations
- Automation of teaching services aimed at students.
- Links with the educational community and professors from other universities
- Digital initiatives aligned with corporate strategy.
- Relations with communities and social groups
- Positioning through digital platforms
- Identification of points of improvement in digital services
- Analysis of positioning indicators
- Relationships with Foundations/NGOs
- Analysis of student perceptions in RRSS

Firstly, it was verified if the assumptions were met to carry out the factorial analysis on the data (Table 22).

Table 24. KMO and Bartlett's Test – IT Governance.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0,848
Bartlett's Test of Sphericity	Approx. Chi-Square	944,855
	df	66
	Sig.	0,000

As could be observed in the previous table, the statistical tests indicate that the data meet the conditions to apply the factorial analysis, obtaining a KMO = 0.848 and the Bartlett's Sphericity test being significant (Chi-square = 944.855; $p < 0.01$). Table 23 shows the results of applying the Component Analysis

Table 25. Total Variance Explained.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	6,339	52,824	52,824	6,339	52,824	52,824
2	1,828	15,237	68,062	1,828	15,237	68,062
3	1,137	9,473	77,535	1,137	9,473	77,535
4	0,673	5,609	83,144			
5	0,568	4,736	87,881			
6	0,412	3,430	91,310			

7	0,319	2,657	93,968			
8	0,197	1,639	95,607			
9	0,175	1,457	97,063			
10	0,163	1,357	98,420			
11	0,116	0,969	99,390			
12	0,073	0,610	100,000			

The solution presents three factors, which collect 77.5% of the total variability (Table 24). As the first factor stands out as being the most relevant because it explains the dimension to a greater degree (52.82%), variables began to be excluded until only one factor was obtained, this being the methodology used for the previous dimensions.

Table 26. Component Matrix.

Nº	Indicator	Component		
		1	*2*	*3*
3.1.2	Relations with international universities	0,914		
3.1.3	Relations with companies and corporations	0,892		
3.1.5	Links with the educational community and professors from other universities	0,872		
3.1.7	Relations with communities and social groups	0,846	0,325	
3.1.11	Relationships with Foundations/NGOs	0,782	0,354	
3.1.4	Automation of teaching services aimed at students	0,513		0,406
3.1.12	Analysis of student perceptions in RRSS		0,871	
3.1.9	Identification of points of improvement in digital services		0,859	
3.1.10	Analysis of positioning indicators		0,823	
3.1.8	Positioning through digital platforms			0,801
3.1.6	Digital initiatives aligned with corporate strategy			0,786
3.1.1	Promotion of projects on digital issues			0,785

On the first factor, six variables are relevantly loaded, mostly associated with relationships and links with other organizations, such as. international universities (3.1.2 - 0.914), companies and corporations (3.1.3 - 0.892), educational communities and professors from other universities (3.1.5 - 0.872), communities and social groups (3.1.7 - 0.846), and to a lesser extent with Foundations/NGOs (3.1.11 - 0.782).

For the conformation of the second factor, three indicators are important, all related, in some way, to analytical functions: Analysis of perceptions of students in RRSS (3.1.12 - 0.871), Identification of opportunities for improvement in digital services (3.1.9 - 0.859) and Analysis of positioning indicators (3.1.10 - 0.823). In the third factor they also load three variables with a similar magnitude, they are: 3.1.8, 3.1.6 and 3.1.1.

To reduce the number of factors that satisfactorily explain this dimension, variables were excluded from the model. To do this, in principle dimensions 3.1.8 and 3.1.1 are eliminated, obtaining a two-factor solution, explaining 73.9% of the total variability. The underlying structure of these two constructs is shown in Table 25.

Table 27. Component Matrix.

Nº	Indicator	Component	
		1	*2*
3.1.2	Relations with international universities	0,918	
3.1.3	Relations with companies and corporations	0,907	
3.1.5	Links with the educational community and professors from other universities	0,881	
3.1.7	Relations with communities and social groups	0,856	0,314
3.1.11	Relations with Foundations/NGOs	0,789	0,362
3.1.4	Automation of teaching services aimed at students	0,516	0,300
3.1.12	Analysis of student perceptions in RRSS		0,874
3.1.9	Identification of points of improvement in digital services	0,304	0,856
3.1.10	Analysis of positioning indicators	0,306	0,842
3.1.6	Digital initiatives aligned with corporate strategy		0,640

Regarding the first factor, the indicators associated with relationships and links with other organizations are maintained, while variables with connotations in the analysis are loaded in the second factor. Given

these circumstances, it would be possible to use two factors, or seek that all the variables load in the second factor, requiring for this to exclude variables until the desired result is obtained.

Opting for the second form of action, variables 3.1.12, 3.1.9, and 3.1.6 were excluded, obtaining the results shown in table 26.

Table 28. Total Variance Explained.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	4,789	68,421	68,421	4,789	68,421	68,421
2	0,739	10,551	78,972			
3	0,682	9,736	88,708			
4	0,334	4,776	93,484			
5	0,197	2,810	96,294			
6	0,140	2,001	98,295			
7	0,119	1,705	100,000			

The axis that was obtained as the final solution explains 68.4% of the total variability, which is considered a good proportion. Table 27 shows the structure of the factor.

Table 29. Component Matrix.

Nº	Indicator	Component
		1
3.1.5	Links with the educational community and professors from other universities	0,920
3.1.7	Relations with communities and social groups	0,914
3.1.2	Relations with international universities	0,896
3.1.3	Relations with companies and corporations	0,895
3.1.11	Relationships with Foundations/NGOs	0,868
3.1.10	Analysis of positioning indicators	0,625
3.1.4	Automation of teaching services aimed at students	0,601

Competencies and abilities. This dimension is made up of five indicators:

- Continuous learning ability
- Change tolerance.
- Training focused on digital technologies.
- Training in digital pedagogical strategies
- Promotion of collaborative learning in RRSS

Table 30. KMO and Bartlett's Test – Competencies and abilities.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0,806
Bartlett's Test of Sphericity	Approx. Chi-Square	188,013
	df	10
	Sig.	0,000

The results of the statistical tests shown in table 28 indicate that Factorial Analysis can be applied to the data, obtaining a value of 0.806 in the KMO test and a significant result in the Bartlett's Sphericity test (Chi- squared = 188.013, $p < 0.01$).

After performing the Principal Components Analysis on the data, the results shown in table 29 were obtained.

Table 31. Total Variance Explained.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	2,961	59,225	59,225	2,961	59,225	59,225
2	0,898	17,959	77,184			
3	0,488	9,762	86,946			
4	0,384	7,684	94,631			
5	0,268	5,369	100,000			

The solution produces a single factor, explaining 59.2% of the total variability. This result validates that all the indicators considered can be considered in a single dimension, as a latent variable. His composition: that is, the way in which the indicators load on the factor can be seen in table 30.

Table 32. Component Matrix.

Nº	Indicator	Component
		1
3.2.3	Training focused on digital technologies	0,920
3.2.1	Continuous learning ability	0,914
3.2.2	Change tolerance	0,896
3.2.4	Training in digital pedagogical strategies	0,895
3.2.5	Promotion of collaborative learning in RRSS	0,601

Except for the indicator: 'Promotion of collaborative learning in social networks' (3.2.5), all the variables have a high contribution to the formation of the factor, above 0.8. The most important indicators were associated with training and learning, specifically: 'Training focused on digital technologies' (3.2.3 - 0.920) and 'Continuous learning ability' (3.2.1 - 0.914).

Internal process management. This dimension is the last one to be considered in this model of digital transformation in the university, being made up of four indicators:

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

Compliance with the assumptions to perform the factorial analysis is shown in the following table (table 31).

Table 33. KMO and Bartlett's Test – Internal process management.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0,715
Bartlett's Test of Sphericity	Approx. Chi-Square	221,136
	df	6
	Sig.	0,000

The Principal Components Analysis yielded the results shown in table 32.

Table 34. Total Variance Explained.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	2,860	71,502	71,502	2,860	71,502	71,502
2	0,705	17,622	89,124			
3	0,236	5,889	95,013			
4	0,199	4,987	100,000			

As in the previous dimension, all the indicators load on a single factor, explaining a significant proportion of the total variability (71.5%). This result indicates that all the indicators that make up this dimension can be considered as a single construct, validating its theoretical conformation. To delve deeper into the conformation of this factor, table 33 explores its structure.

Table 35. Component Matrix.

Nº	Indicator	Component
		1
3.3.3	Technologies in back-office optimization of the organization	0,878
3.3.1	Decision making incorporating IT	0,850
3.3.2	Digital technologies in workflows	0,831
3.3.4	Data-driven decision making	0,823

In the Component Matrix it can be observed that all the variables that make up the 'Internal Processes Management' dimension have a relevant and similar load on the factor; this indicates that in the conceptualization of this construct, all the indicators have the same weight or importance.

4.2. Confirmatory Factor Analysis

Preliminary considerations. To validate the theoretical model of the digital transformation process of the Autonomous University of Chile, the Confirmatory Factor Analysis (CFA) was used, which aimed to find out if said theoretical model satisfactorily fits the data, thus achieving empirical validation.

Although there is no agreement on the matter, for the CFA it is recommended that the sample size be 10 to 20 cases for each item or variable (Thompson, 2004). Other authors, such as Lloret-Segura et al. [35] point out that the sample size should not be less than 200 cases. In this case, the sample size is 97 cases, a small size. In addition, a dimension was found that only contained two indicators (Financial Resources), when the recommended minimum is three variables or indicators.

To solve this situation, the Unweighted Least Squares (ULS) method was used. This method is recommended when the sample size is small, as well as when the dimensions have few variables.

It should be noted that with this method it is not possible to calculate all the indicators associated with the quality of the fit, nor the t statistics on the significance of the estimated parameters. In principle, it was decided to use the same structure of the proposed model, although the Exploratory Factor Analysis indicates that there are some indicators that are not very relevant in the formation of the factor (latent variable).

To know the goodness of fit, the different indicators calculated using AMOS were examined, which are shown in Table 34.

Table 36. Goodness-of-Fit Indicators.

Indicator	Value
NFI	0,927
GFI	0,933
AGFI	0,927
RMR	0,070

The *Normed Fit Index* (NFI) measures the proportion of 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. It is considered acceptable when the value is greater than 0.90. In the adjustment of the model found the NFI = 0.927, being higher than 0.90, indicating that the variability explained by the model is acceptable (92.7%).

The *Goodness-of-fit index* (GFI) guides whether the model should be adjusted. The closer it is to zero, the worse the fit, while values greater than 0.90 are good. In the case of the model under analysis, the GFI = 0.933 (GFI > 0.90), which indicates that there is a good fit.

Related to the previous index, the *Adjusted Goodness-of-fit Index* (AGFI) corrects the tendency of the GFI to increase as the sample is larger, adjusting the value by degrees of freedom. The acceptance criterion is the same as that of the Goodness of Fit Index; that to be acceptable, the values must be greater than 0.90. Table 34 shows that the AGFI = 0.927; maintaining the criterion that the fit to the model is good.

Finally, the *Root Mean Squared Residual* (RMR) is an index based on residuals, which measures the differences between the matrix of variances and covariances of the sample with that of the model estimates. This value must be close to zero to be acceptable. In this case, the RMR = 0.070 is quite close to zero, so the model would be acceptable under the previous criteria.

In short, considering all the indices of the goodness of fit to the model and the proportion of variance explained, it can be stated that there is a good fit of the model, reaching the conclusion that the proposed model fits the data and is empirically validated.

Estimated parameters of the digital transformation model. According to Ruiz (2000), the equations that define the model will be, for the exogenous variables:

$$x1 = \lambda 11\xi 1 + \delta 1$$
$$x2 = \lambda 21\xi 1 + \delta 2$$
$$x3 = \lambda 31\xi 1 + \delta 3$$
$$x4 = \lambda 41\xi 1 + \delta 4$$
$$.$$
$$.$$

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

Where:
Xi the observed variables (i= 1,2,3, ...),
λ_{is} are the weights or structural coefficients of the i-th variable over the latent variable *s*.
ξ_s corresponds to the latent variables (s = 1,2,3, …).
δ_i the measurement errors for each observed variable.

For the endogenous variables of the model, the equations are:

$$y1 = \lambda 11\eta 1 + \varepsilon 1$$
$$y2 = \lambda 21\ \eta\ 1 + \varepsilon 2$$
$$y3 = \lambda 31\ \eta\ 1 + \varepsilon 3$$
$$y4 = \lambda 41\ \eta\ 1 + \varepsilon 4.$$
$$.$$
$$.$$
$$yk = \lambda ks\ \eta\ 2 + \varepsilon\ k$$

Where:
y_i the observed variables (i= 1,2,3, ...),
λ_{is} are the weights or structural coefficients of the i-th variable over the latent variable *s*.
η_s corresponds to the latent variables (s = 1,2,3, …)
ε_i are the measurement errors for each observed variable.

Table 35 show the estimated parameters for each indicator.

Table 37. Estimated parameters (indicators).

Variable	Dimension	Estimated parameter	Estimated error
P1.1.1	Strategy and Culture	0,781	0,610
P1.1.2		0,775	0,601
P1.1.3		0,663	0,439
P1.2.1	Financial resources	0,872	0,760
P1.2.2		0,955	0,913
P1.3.1	Technological Base	0,726	0,527
P1.3.2		0,728	0,530
P1.3.3		0,652	0,425
P1.3.4		0,582	0,339
P1.3.5		0,688	0,473
P1.3.6		0,795	0,633
P2.1.1	Focus on the student	0,650	0,422
P2.1.2		0,691	0,478
P2.1.3		0,704	0,495
P2.1.4		0,652	0,425
P2.1.5		0,730	0,533
P2.1.6		0,740	0,548
P2.1.7		0,716	0,513
P2.1.8		0,633	0,401
P2.1.9		0,685	0,470
P2.2.1	Teaching-learning processes	0,708	0,501
P2.2.2		0,705	0,498
P2.2.3		0,744	0,554
P2.2.4		0,723	0,522
P2.2.5		0,697	0,485
P2.2.6		0,693	0,480
P2.2.7		0,700	0,490
P2.2.8		0,731	0,534
P2.2.9		0,685	0,470
P2.3.1	Economic-administrative processes	0,735	0,540
P2.3.2		0,650	0,422
P2.3.3		0,623	0,389
P2.3.4		0,726	0,526
P3.1.1	IT governance	0,735	0,432
P3.1.2		0,650	0,379
P3.1.3		0,623	0,546
P3.1.4		0,726	0,357
P3.1.5		0,657	0,543

P3.1.6		0,616	0,465
P3.1.7		0,739	0,508
P3.1.8		0,597	0,461
P3.1.9		0,737	0,559
P3.1.10		0,682	0,599
P3.1.11		0,713	0,520
P3.1.12		0,679	0,578
P3.2.1	Competences and Abilities	0,584	0,340
P3.2.2		0,493	0,243
P3.2.3		0,675	0,455
P3.2.4		0,805	0,649
P3.2.5		0,760	0,578
P3.3.1	Internal Process Management	0,812	0,659
P3.3.2		0,819	0,670
P3.3.3		0,818	0,669
P3.3.4		0,692	0,479

The previous table contains the parameters to estimate the indicators. When analyzing the estimated parameters for each coefficient, it was observed that all of them are of significant magnitude ($\lambda > 0.5$), being interpreted as contributing significantly to the explanation of the respective latent variable.

The most relevant coefficients are found in the dimensions: Financial Resources and Management of Internal Processes. For the first dimension (financial resources) its only two indicators stand out, while in the second dimension (management of internal processes) the three indicators with coefficients greater than 0.80 stand out.

Table 36 shows the parameters to estimate the values of the nine dimensions or latent variables of the model.

Table 38. Estimated parameters (Dimensions).

Variable	Estimated parameter	Estimated error
Strategy and Culture (1.1)	0,887	0,787
Financial resources (1.2)	0,681	0,464
Technological Base (1.3)	0,941	0,886
Focus on the student (2.1)	0,998	0,995
Teaching-learning processes (2.2)	0,970	0,941
Economic-administrative processes (2.3)	0,970	0,942
IT governance (3.1)	0,860	0,740
Competences and Abilities (3.2)	0,979	0,958
Internal Process Management (3.3)	0,856	0,733

In the previous table almost all the coefficients of the dimensions are greater than 0.80, the exception being the estimated coefficient associated with the dimension of 'Financial Resources' (0.681), although its magnitude is relevant; In addition, it has the largest estimated error, indicating that its estimate is less precise than the rest of the dimensions ($\varepsilon k = 0.464$).

Figure 1 show the diagram of causal relations of the Digital Transformation Model of the Autonomous University of Chile.

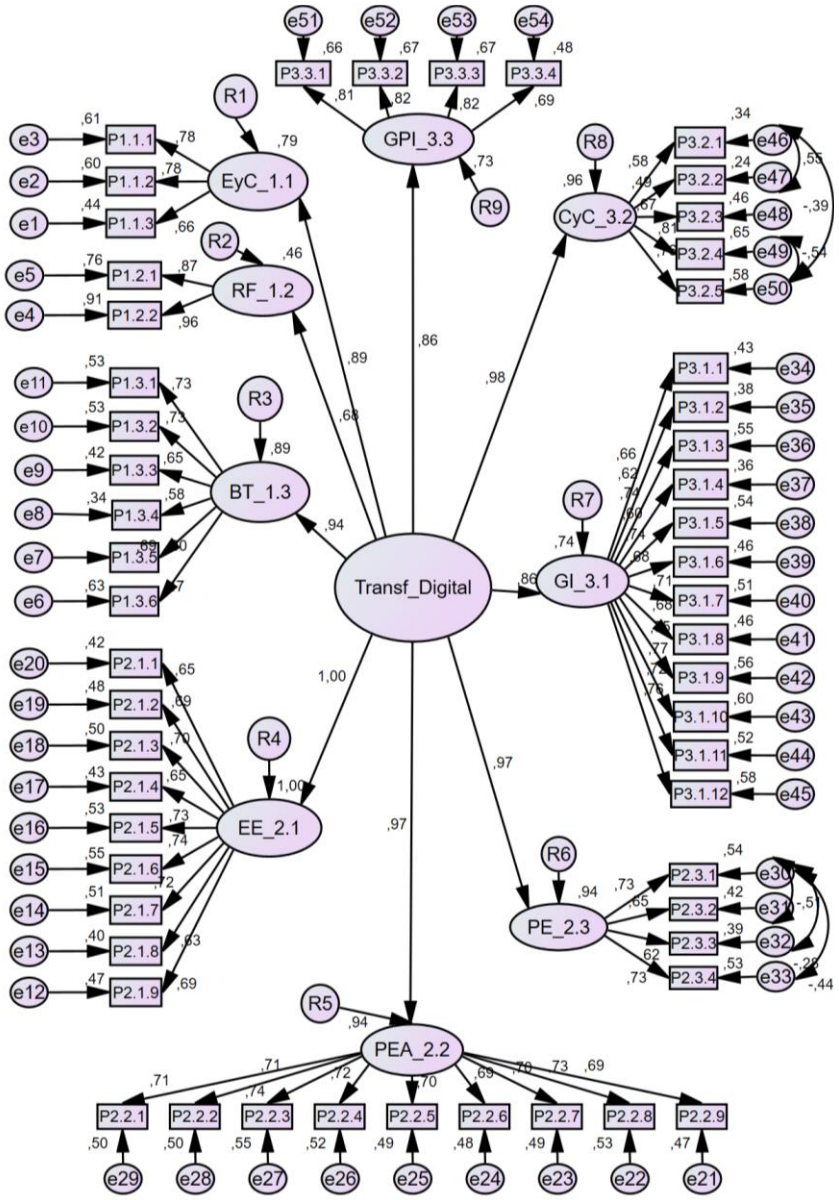

Figure 1. Diagram of Causal Relations (with parameters) of the Digital Transformation Model of the Autonomous University of Chile

Legend: EyC: Strategy and Culture; RF: Financial Resources; BT: Technological Base; EE: Student Focus; PEA: Teaching-Learning Processes; PE: Economic-administrative processes; IG: IT Governance; CyC: Competences and Abilities; GPI: Internal Process Management

5. Conclusions

The Exploratory Factor Analysis (EFA) confirms that most of the indicators can be included in a single construct or dimension. In cases where this does not occur, restructuring the composition of the dimension makes it possible for all the indicators to load on a single factor.

The findings found in the EFA were the starting points that served as orientation when respecifying the model through Confirmatory Factor Analysis (CFA). In this sense, after carrying out said analysis, it is concluded that all the variables and their corresponding dimensions, nine in total, form a robust construct that explains the phenomenon studied, so the proposed model on the digital transformation process of Autonomous University of Chile it is adequate and intrinsically validated by the data.

The results of the Confirmatory Factor Analysis allow us to conclude that the "focus on the student" and the "skills and abilities" are the two most relevant dimensions in the process of digital transformation of the Autonomous University of Chile. On the other hand, surprisingly, the “financial resources” dimension is the one that contributes the least to this process, although it is necessary to consider that this dimension is the one with the largest estimated error, therefore it is the least precise.

However, and in view of the limitations regarding the size of the sample, the model analyzed is not susceptible to generalization since it only constitutes the representation of a reality that is circumscribed to the context in which the data was collected. In this sense, it is recommended to replicate this study using the same theoretical model but increasing the volume of the data to a minimum of 200 cases, while considering that the ideal sample size should contain 10 to 20 cases for each one. of the variables or indicators that are analyzed (Thompson, 2004). As the model has 54 indicators, the number of cases should not be less than 540.

On the other hand, to carry out the Confirmatory Factor Analysis it is advisable to increase the number of indicators in the 'Financial Resources' dimension to a minimum of three variables. If the previous recommendations are met, it will be possible to apply other methods in the CFA, such as the Maximum Likelihood method or the Generalized Least Squares method, methods considered more robust than the Unweighted Least Squares method that was used to carry out this study.

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ARTÍCULO 4

Impact of university digital transformation on the satisfaction of students at the Autonomous University of Chile

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Article

Impact of university digital transformation on the satisfaction of students at the Autonomous University of Chile

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, seek their loyalty to the institution, 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 et al. [1]. To determine the impact of the digital transformation on the satisfaction of university students, the structural equation modeling technique was applied, using for this purpose 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, the more difficult it will be to satisfy students and achieve their loyalty.

Keywords: digital transformation; higher education; student satisfaction

1. 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 [2] 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 [3]; 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 [4].

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 [5]. 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 [6], 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 [7]. This leads to a new global and intensely interconnected scenario that highlights the importance of ideas, innovation, and relationships [8].

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 [9]. 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 [9] 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 digital transformation model that was specifically designed for the Autonomous University of Chile, was studied in terms of its impact on student satisfaction and loyalty to the institution. The model used for this purpose was the Student Satisfaction Index, which was created by Turkyilmaz et al., [1].

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

1.1. Description of 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.

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 et al. [10], Crespo and Pariente [6], Furedi [11], Gobble [12], Salinas and Vio [13], Sánchez and Fernández [14] and Valdez-de-León [15].

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).

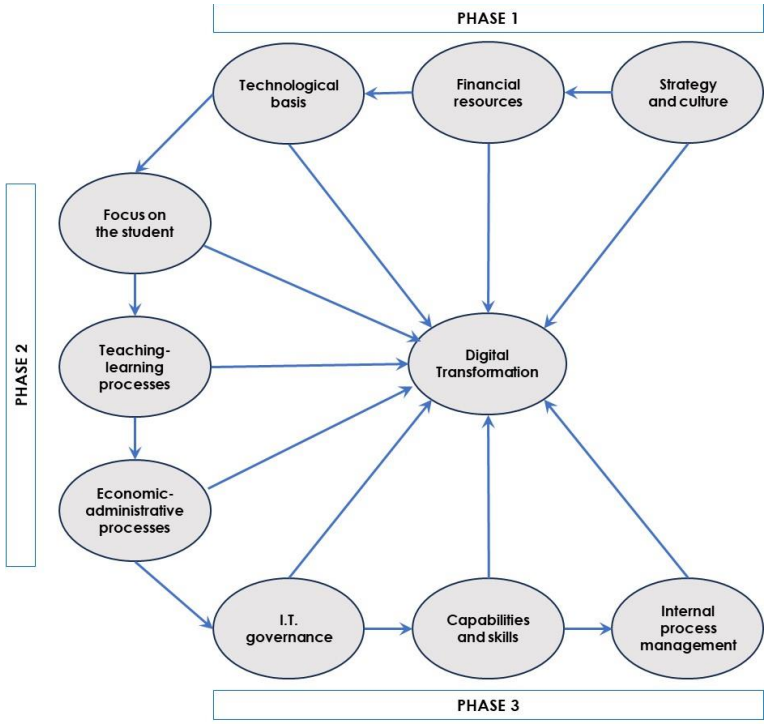

Figure 1. Graphic representation of the Digital Transformation Model of the Autonomous University of Chile.

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. 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. 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 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.

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. 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. Together with the teaching-

learning processes, the economic-administrative processes impact the student experience and can be a determining factor in decisions about the continuation of studies.

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. 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.

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.

1.2. Description of Student Satisfaction Index Model (SSI)

The Student Satisfaction Index Model (SSI) proposed by Turkyilmaz, et al. [1], 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.

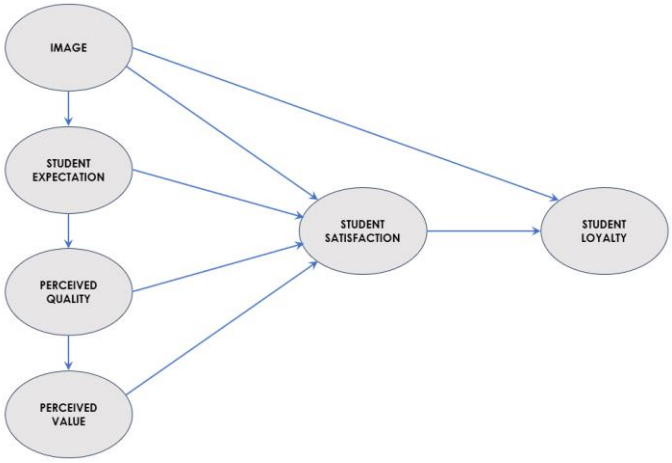

Figure 2. Graphic representation of the Student Satisfaction Index Model (SSI). Note: adapted from Turkyilmaz et al. [1] (p. 123)

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, et al. [1] 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.

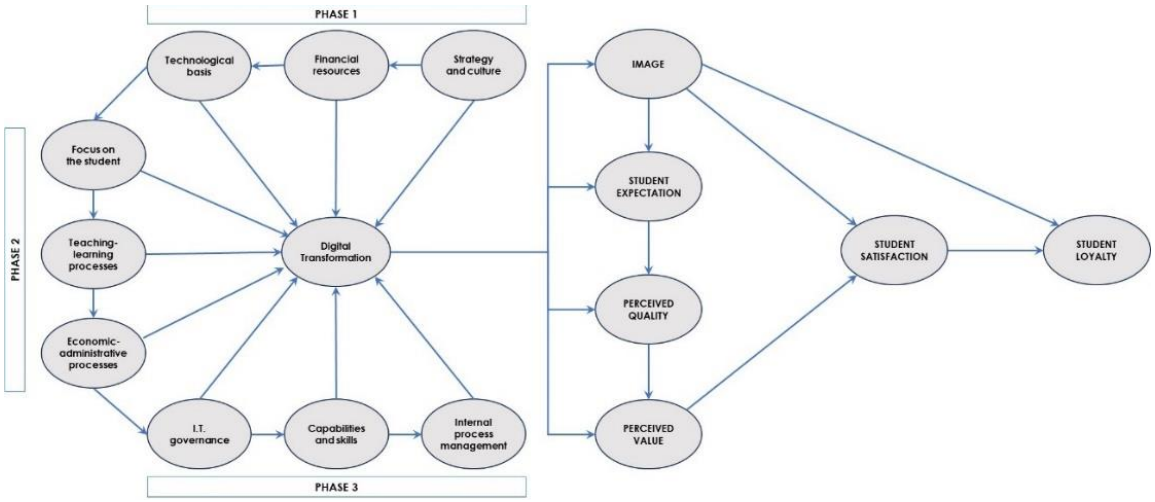

Figure 3. Hypothetical relationship between Digital Transformation Model of the Autonomous University of Chile (DTM) and Student Satisfaction Index Model (SSI).

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”.

2. Materials and Methods

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 [16]. 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 > 0.7); 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 [17]. Other authors point out that the sample size should not be less than 200 cases [18]. 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 [19].

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.

3. Results

This section presents the results of the Exploratory Factor Analysis and the Confirmatory Factor Analysis.

3.1. Exploratory Factor Analysis

Below, Table 1 shows the results obtained for each of the dimensions of the Student Satisfaction Index model, proposed by Turkyilmaz et al. [1]

Table 1. KMO and Bartlett's Sphericity tests

Dimension	KMO [1]	Bartlett´s 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

[1] Kaiser-Meyer-Olkin Measure of Sampling Adequacy

[2] Bartlett's Sphericity test

In all dimensions, the Bartlett 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.

3.1.1. 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	Item	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).

3.1.2. 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	Item	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.

3.1.3. 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 - Perceived 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 - Perceived quality

Nº	Item	Component
		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).

3.1.4. Dimension 4: Perceived 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 - Perceived value

Nº	Item	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.

3.1.5. 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	Item	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.

3.1.6. 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	Item	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

Componentes	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	Item	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.

3.2. Confirmatory Factor Analysis

3.2.1. 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, et al. [1].

Table 16. Kolmogorov-Smirnov Normality Test

Variable	Statistic	df	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
*** Perceived 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
*** Perceived 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 [20]. 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.

3.2.2. Evaluation of Confirmatory Factor Analysis

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

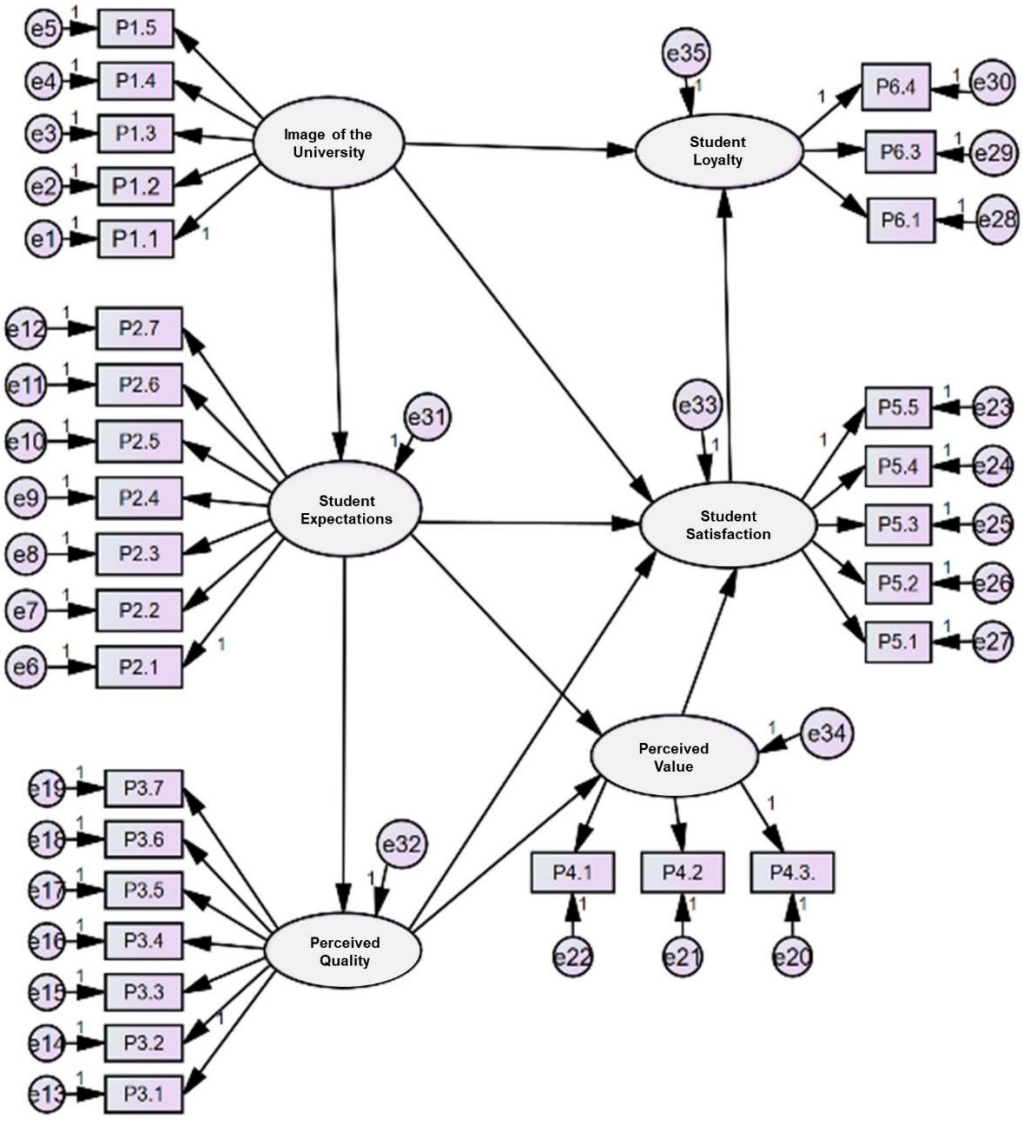

Figure 4. Diagram of causal relationships

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

Table 17. Fit index and values

Fit 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.

3.2.3. Estimated model parameters

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

$$x1 = \lambda 11\xi 1 + \delta 1$$
$$x2 = \lambda 21\xi 1 + \delta 2$$
$$x3 = \lambda 31\xi 1 + \delta 3$$
$$x4 = \lambda 41\xi 1 + \delta 4$$
$$\vdots$$
$$x\mathrm{k} = \lambda \mathrm{ks}\ \xi \mathrm{s} + \delta 4$$

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:

$$\mathrm{y1} = \lambda 11\eta 1 + \varepsilon 1$$
$$\mathrm{y2} = \lambda 21\ \eta 1 + \varepsilon 2$$
$$\mathrm{y3} = \lambda 31\ \eta 1 + \varepsilon 3$$
$$\mathrm{y4} = \lambda 41\ \eta 1 + \varepsilon 4$$
$$\vdots$$
$$\mathrm{yk} = \lambda \mathrm{ks}\ \eta 2 + \varepsilon\ \mathrm{k}$$

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

Table 18. Parameter Estimation

Items	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
- Expected 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
- Expected 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 ($\lambda > 0.5$), 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

Variables	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.

Figure 5 shows the causal relationship diagram (path diagram) with parameters. Parameter estimates are standardized values.

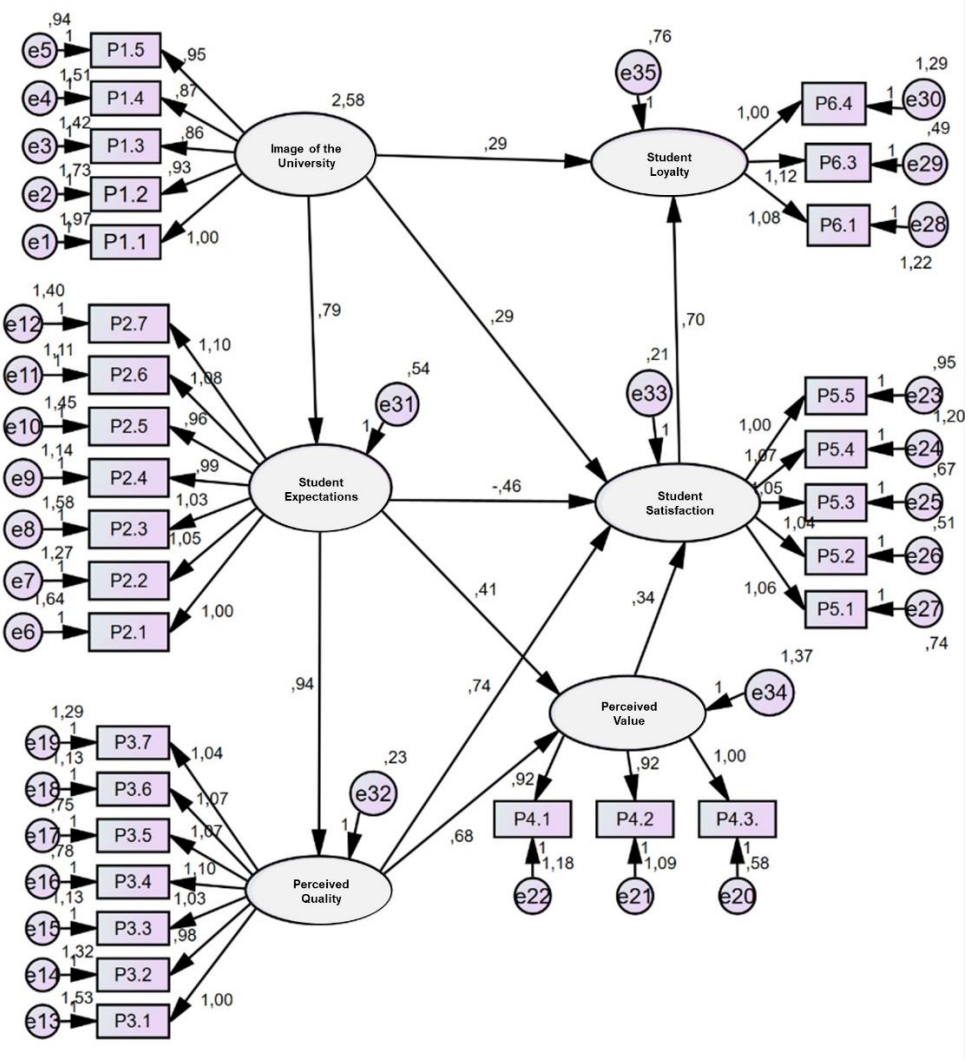

Figure 5. Path diagram

5. 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. From this it is interpreted that the level of satisfaction shown by the student is influenced by aspects of a subjective nature, which considers both past experiences and future expectations. In the same way, satisfaction depends on the way in which the student perceives the quality of education, the effectiveness of the pedagogical models, the capacities of the teachers and the quality of the services they receive, but also, the student's perceptions about the image of the University in the academic and social context are also involved, which can have an impact on the possibilities of accessing the job market.

From this perspective, the results obtained demonstrate the potential impact of the digital transformation of the Autonomous University of Chile on student satisfaction. Of course, this transformation process requires educating teachers and students in digital skills, as well as incorporating deep changes in the management of the University in such a way that it can adapt

quickly to the constant challenges posed by a digital environment characterized by continuous changes and increasing social demands.

In any case, the results obtained reinforce the idea that the only justification for implementing the digital transformation model is to put the technological capabilities of the University at the service of students and teachers.

On the other hand, the results show that Satisfaction and the Image of the university have an impact on Loyalty, with satisfaction being the most relevant. In this regard, it should be noted that perceived quality is the variable that has the greatest effect on student satisfaction, so the digital transformation of the University should 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, since these influence satisfaction in a negative way; that is, the higher the expectations that the student has about the benefits of the digital transformation of the University, the more difficult it will be for them to obtain a high level of satisfaction.

Finally, it is shown that a requirement that cannot be dispensed with to achieve a good level of student loyalty towards the educational institution is to maintain high levels of Satisfaction, beyond the image that the university may have. This leads us to understand that the true digital transformation of the Autonomous University of Chile does not refer to a simple process of digitalization of its processes, or to the application of online learning technologies, but that it demands a series of profound and coordinated changes that support new teaching and learning models, and that transform the internal processes and strategic orientations of the University.

Consequently, it is interpreted that the purpose of digital transformation is to offer students a new value proposition, in accordance with the characteristics of the technological, economic, and social context. All of this within a framework that safeguards ethical principles and reduces the inequality of training and employment opportunities.

In conclusion, using as a reference the Student Satisfaction Index model that was created by Turkyilmaz et al. [1] and using a system of structural equations, it was possible to demonstrate the potential impact of the digital transformation of the Autonomous University of Chile in the satisfaction of the students and in their loyalty towards the institution. However, the results obtained cannot be extrapolated to other university contexts since the digital transformation model was specifically designed for this University, after considering its cultural and structural particularities.

In any case, in view of the indisputable relationship between digital transformation and student satisfaction, the deepening of this object of study in relation to the use of digital technologies at the University for the promotion of humanistic values, such as inclusion, justice and equality; understanding these as factors that favor the improvement of the human condition and determine their impact on the levels of satisfaction of the student community. In the same way, it would be convenient to analyze the repercussions of the digital transformation of the University in the decision-making processes in which students are involved.

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6. DISCUSIÓN GLOBAL DE LOS RESULTADOS

No cabe duda de que las instituciones de educación superior están atravesando una etapa en su proceso de desarrollo en la que buscan adaptarse a los requerimientos de la sociedad contemporánea; una sociedad que lucha por amoldarse a un mundo tecnológicamente desarrollado, pero cuyo futuro, aún incierto, está en pleno proceso de construcción. Esta evolución trasciende el simple hecho de adoptar nuevas tecnologías, ya que también implica la transformación estratégica de toda la organización, tomando como centro de atención la experiencia del estudiante y apoyándose para ello en las virtudes y oportunidades que ofrecen las tecnologías digitales.

Son varios los impulsores de este proceso evolutivo de las universidades que han sido documentados en la literatura; entre ellos destacan: la democratización del conocimiento junto con los nuevos comportamientos digitales (Wildan et al., 2018) y las mayores expectativas sobre los beneficios de la transformación digital en la actual economía del conocimiento (Marks & AL-Ali, 2022). Todo ello parece estar generando una mayor competencia en el sector educativo y una sensación de urgencia en cuanto a la necesidad de aprovechar las capacidades digitales que deben gestionar las universidades, siendo evidente el creciente interés que demuestran por iniciar procesos de transformación digital con el que procuran atraer más estudiantes, mejorar las experiencias que derivan de los procesos académicos y administrativos, y aprovechar la tecnología para la creación de mayor valor.

En este sentido, la transformación digital, entendida como el conjunto de cambios en el modelo de negocios de una organización, que son causados por la adopción de tecnologías digitales emergentes e impactan en las estructuras organizacionales, sus productos o sus servicios (Hess et al., 2016), está ofreciendo nuevas oportunidades para la transformación estratégica de las instituciones de educación superior, incluyendo la gestión del capital humano, la información, los procesos y las tecnologías.

Este proceso de transformación no ha pasado desapercibido por la comunidad científica, habiéndose demostrado el creciente interés que ha despertado este objeto de estudio, así como la conformación de un corpus teórico, aún incipiente, que contribuye a establecer una panorámica sobre las tendencias mundiales relacionadas con la transformación digital en las instituciones de educación superior. Al respecto, al revisar la literatura se puede observar la coincidencia en cuanto al cada vez mayor interés por comprender el fenómeno

de la digitalización en las organizaciones educativas, ya sea desde el punto de vista de las competencias necesarias para la transformación digital, como de las actividades implícitas en dicho proceso; los estudios de González-Zamar et al. (2020) y Abad-Segura et al. (2020) así lo atestiguan.

Tomando en consideración que la presencia del Covid-19 fue una variable que aceleró esta transformación a niveles nunca vistos, se pudiera explicar el marcado incremento experimentado a partir del año 2019 en el número de artículos, actas y reseñas relacionadas con la transformación digital en los procesos organizacionales, tal como quedó evidenciado en el análisis bibliométrico que forma parte de esta investigación, concretamente al aplicar una de las leyes bibliométricas fundamentales como lo es la Ley de Price, la cual mostró un crecimiento exponencial en el número de publicaciones (R2 = 92%). Sin embargo. al dibujar una panorámica global de las producciones científicas más significativas en esta materia, llama la atención que ese interés no se refleja de manera homogénea en el contexto global, siendo notorio el predominio de las producciones científicas realizadas en Europa (España, Portugal, Alemania, Reino Unido e Italia), Estados Unidos, China, Rusia y Australia.

En todo caso, es necesario destacar que la mayoría de dichas investigaciones están relacionadas con la transformación digital en organizaciones comerciales y de servicios, pero no de manera específica en el contexto de la educación superior en donde se revela, según la Ley de Bradford, una alta concentración de publicaciones en 14 revistas, siendo las más destacadas: *"Science Education", "Education and Information Technology"*, y especialmente *"Sustainability"* la cual concentra el 33,3% de las publicaciones sobre este objeto de estudio.

A pesar de que el estudio bibliométrico se realizó tomando como referencia el periodo 2014-2022, y por lo tanto incluyó el acelerado proceso de transformación educativa que se produjo a raíz de la pandemia del Covid-19, los países que concentran una alta tasa de estudiantes de educación superior en Latinoamérica, África y la mayor parte del continente asiático no están representados en las principales bases científicas de datos que abordan los procesos de transformación digital de las universidades. Esta omisión pudiera deberse a que en muchos países, más que la intención de lograr un mayor nivel de madurez digital en la Universidad, el interés haya estado centrado en convertir apresuradamente un modelo de enseñanza presencial en un modelo online, siendo

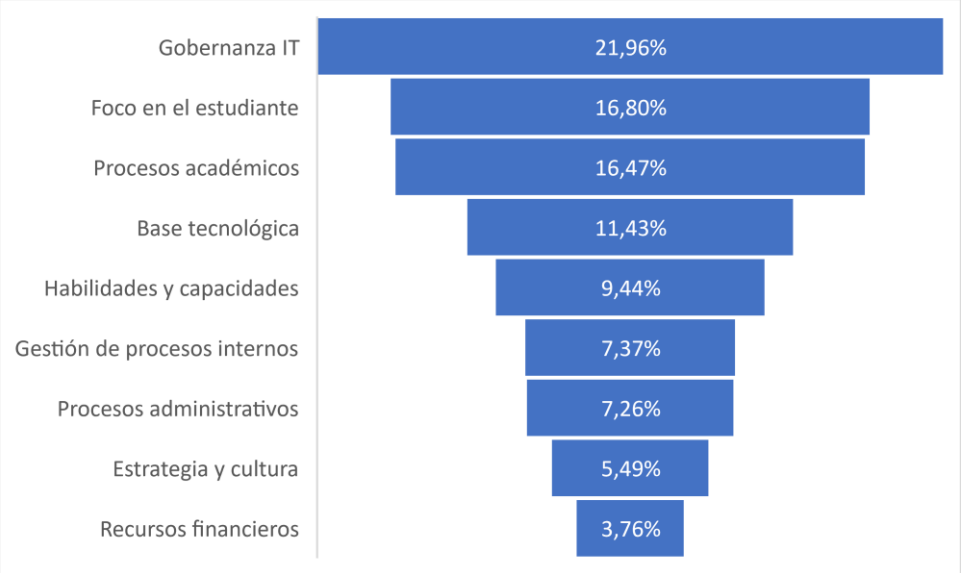
oportuno reconocer que ese interés, legítimo en cuanto a su naturaleza, obedecía a la necesidad de responder urgentemente y con los medios disponibles a una situación sobrevenida de emergencia, que impedía realizar los cambios organizacionales profundos que requiere cualquier proceso de transformación digital (Brown et al., 2020).

En este orden de ideas, asumiendo junto con Orellana et al. (2019) que la transformación digital habilita nuevos procesos organizacionales y procura crear una propuesta de valor que trasciende el elemento tecnológico para responder adecuadamente al entorno competitivo digital (Brown et al., 2020), es de entender que toda decisión que se tome en este sentido deberá ser coherente con su filosofía y cultura, de manera tal que el proceso de cambio se desarrolle de forma sostenible en toda la organización y a lo largo del tiempo. Esta es la razón por la que Fernández et al. (2023) señala que alcanzar la madurez digital es un proceso continuo que implica adaptación y aprendizaje, ya que el punto final del cambio digital continuamente se está actualizando.

Es así como en esta investigación, el diseño del modelo de transformación digital de la Universidad Autónoma de Chile obligaba a utilizar los elementos estructurales que tanto la población estudiantil como los expertos en el área consideraron fundamentales. En tal sentido, si bien es cierto que las dimensiones y factores que sustentaron el modelo preliminar fueron extraídos principalmente de los modelos teóricos de Westerman, et al. (2012), Valdez-de León (2016) y Catlin, et al. (2015), y complementados luego con los aportes de Crespo & Pariente (2018); Gobble (2018); Furedi, (2011), Salinas & Vio (2011); y Sánchez & Fernández (2010), era obligante para los autores elaborar dicho diseño desde una perspectiva sistémica que permitiera satisfacer las necesidades de todos los agentes involucrados en el contexto universitario y que, a su vez, considerara los aspectos organizacionales, socioculturales y tecnológicos, en perfecta armonía con los requerimientos de la comunidad educativa y de forma coherente con las necesidades y expectativas de la sociedad.

Esto permitió determinar, en primer lugar, las dimensiones del modelo de transformación digital de la Universidad Autónoma de Chile, e identificar la contribución de cada una de ellas a la madurez digital de la Universidad. Los resultados no dejan lugar a dudas sobre el significativo impacto de la gobernanza tecnológica, pero al mismo tiempo demuestra que los recursos financieros no son los que determinan el éxito del proceso de transformación, tal como se puede apreciar en la Figura 2.

Figura 3. *Dimensiones del proceso de transformación digital y contribución porcentual a la madurez digital de la Universidad Autónoma de Chile*



La figura anterior revela que el fundamento que justifica el proceso de transformación digital no es otro que el de ofrecer mayor valor para el estudiante, ya que ningún esfuerzo de digitalización tendría sentido si no está enfocado en la experiencia del usuario, así como en la necesidad de contar con información clara, precisa y oportuna que permita satisfacer sus requerimientos y expectativas. Obviamente, dicho proceso implica conjugar acciones en tres fases:

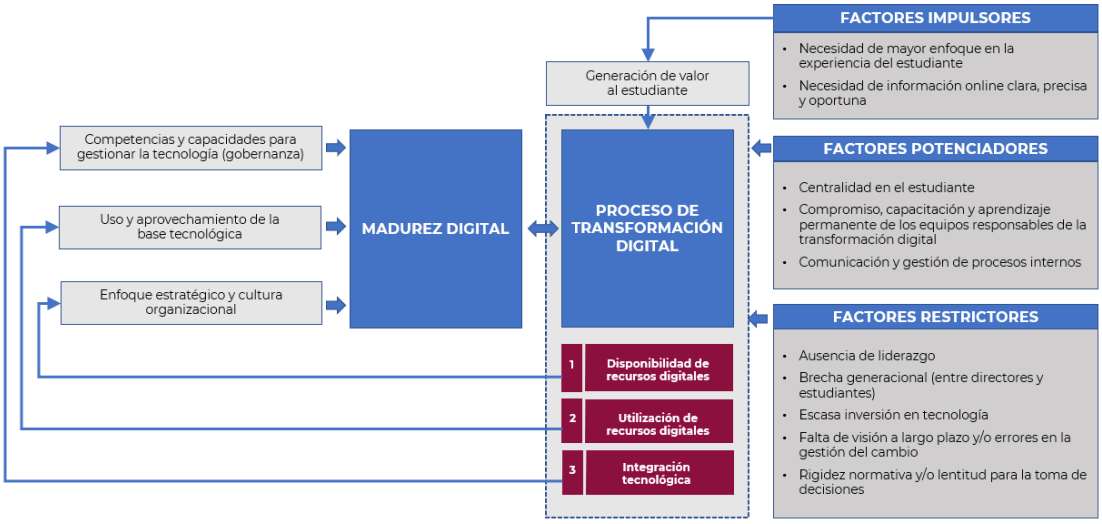
- Primera fase: Disponibilidad de recursos digitales. Requiere el diseño de estrategias específicas sustentadas en un liderazgo claro, la convicción de la necesidad de invertir en equipos e infraestructura y contar con personal altamente calificado y capaz de gestionar el proceso. En consecuencia, se observan tres esferas de influencia que alimentan la primera fase del proceso: estrategia y cultura, recursos financieros y base tecnológica, esta última referida a equipamiento, infraestructura, conectividad y soporte técnico
- Segunda fase: Uso de recursos digitales. Se refiere a la forma en que se utiliza la base tecnológica obtenida en la fase anterior, tanto en términos de procesos académicos como administrativos, e implica un reconocimiento previo del potencial de las nuevas tecnologías para luego generar e implementar iniciativas que favorezcan la experiencia estudiantil, faciliten la gestión de procesos internos

y aumenten los índices de competitividad. El uso de los recursos digitales está consustanciado con el aprovechamiento de la base tecnológica, siendo sus elementos fundamentales: el enfoque en la experiencia del estudiante, la mejora de los procesos de enseñanza-aprendizaje y el uso de las capacidades tecnológicas para la mayor efectividad de los procesos. económico-administrativos.

- Tercera fase: Integración de tecnologías digitales. Relaciona las capacidades internas de la universidad con los cambios que se producen como consecuencia de la evolución tecno-cultural de la sociedad; Es decir, se refiere a los vínculos entre tecnología y medio ambiente, incluyendo el desarrollo de capacidades y la implementación de nuevas propuestas e iniciativas encaminadas a mejorar la gestión institucional, incluso a través de la reconfiguración de las estructuras organizativas clásicas, manteniendo siempre el enfoque en la experiencia del estudiante. Esta última fase del proceso de transformación digital fase se vincula con las competencias y capacidades para gestionar la tecnología, siendo sus elementos fundamentales el gobierno, las competencias y capacidades en materia de tecnología de la información, y la gestión de los procesos internos.

Con base en los resultados de la investigación realizada en la Universidad Autónoma de Chile, en la figura 3 se ilustra el modelo teórico de transformación digital el cual se encuentra mediado por factores que pueden potenciar o dificultar su puesta en marcha.

Figura 4. *Modelo teórico del proceso de transformación digital*



El producto obtenido al realizar el estudio; es decir, el modelo de transformación digital de la Universidad Autónoma de Chile, pone de relieve que ningún modelo teórico estará completo mientras no considere la totalidad de los elementos que la comunidad educativa considere esenciales para poner en marcha un proceso de transformación profunda que conduzca a una mejora en los niveles de madurez digital. Esto representa una contribución importante a la literatura sobre este objeto de estudio ya que no se han encontrado investigaciones que hayan resaltado expresamente la necesidad de considerar las creencias, los valores y las circunstancias particulares de la organización para el diseño de un modelo de transformación digital. Tanto es así que, aunque no se han encontrado diferencias significativas entre los factores considerados, merece destacarse el hecho de que tanto los estudiantes como los docentes creen que la cultura es la dimensión más significativa que interviene en dicho proceso de transformación, por encima incluso de las capacidades críticas y los recursos claves que posea la Universidad.

Esto es consistente con los resultados de un estudio previo realizado por PriceWaterhouseCoopers (PwC) en el que se señala que muchas universidades están desarrollando estrategias digitales específicas como reacción al cambio masivo hacia el uso de nuevas tecnologías, pero la falta de visión, la creencia de que la transformación digital afecta solamente al área de Tecnologías de Información, y la ausencia de un compromiso claro para implementarlas de manera efectiva les impide adaptarse a la era digital (PwC, 2018). De este modo, y tal como lo advierten Castro-Benavides, et al. (2022) existe el riesgo de no considerar soluciones integrales que respondan de forma asertiva a los requerimientos actuales y futuros de las Instituciones en el narco de la cuarta revolución industrial.

En otro orden de ideas, el modelo de transformación digital de la Universidad Autónoma de Chile refleja una clara relación entre la madurez digital y la generación de valor para el estudiante a través de los procesos de enseñanza-aprendizaje y los procesos económico-administrativos, lo cual se vincula con: (1) el enfoque estratégico y la cultura organizacional; (2) el uso y explotación de la base tecnológica disponible; y (3) las competencias y habilidades para manejar la tecnología. Estos tres elementos, que parecen ser determinantes del éxito del proceso de transformación digital de la universidad, exigen que se asuma al estudiante como el centro de atención en el proceso de toma de decisiones, pero también requiere el compromiso, la formación y el aprendizaje

permanente del personas responsables de gestionar el cambio tecnológico, lo que a su vez exige un liderazgo claro, así como una adecuada comunicación y coordinación entre las áreas académico-administrativas que son responsables de gestionar los procesos que se llevan a cabo en la institución.

Estos hallazgos ilustran lo señalado por Pelletier y Hutt (2021) cuando definen la transformación digital como "una serie de cambios profundos y coordinados en cultura, fuerza laboral y tecnología que posibilitan nuevos modelos educativos y operativos, y transforman el modelo de negocios, la dirección estratégica y la propuesta de valor" (p.30). Esto conlleva la necesidad de contar con un liderazgo innovador en todos los niveles de la institución, así como con una eficiente coordinación entre las diferentes unidades. En este sentido y a la luz de los hallazgos de esta investigación, es notoria la amplia y relevante gama de impactos del cambio tecnológico en las instituciones de educación superior, particularmente en las categorías de valores y operaciones, tal como lo revela Núñez et al. (2021) haciendo referencia expresa al caso de las universidades chilenas.

En este sentido, cualquier esfuerzo de cambio hacia la digitalización de los sistemas y procesos universitarios implica que previamente se reconozca el modelo de Universidad al que se aspira llegar; por supuesto, dentro de una lógica digital y en armonía con la misión social de las instituciones de educación superior. Esto no sólo dará un impulso a los mecanismos que garanticen una mayor calidad educativa, sino que también asegurará un proceso de transformación que tenga en cuenta: (1) las competencias digitales (actuales y deseadas) de estudiantes, docentes y responsables de gestionar la incorporación paulatina de las tecnologías en los procesos académico-administrativos, (2) enfrentar los desafíos que plantea la digitalización, y (3) consolidar alianzas nacionales y supranacionales que sirvan de apoyo para iniciar procesos disruptivos que respondan a los nuevos escenarios basados en los avances científico-tecnológicos en el contexto global.

Estos señalamientos permiten inferir que las dificultades financieras que pudiera estar atravesando una Universidad, su tradición cultural, la rigidez regulatoria, la ausencia de una visión clara de lo que se pretende conseguir a través del proceso de transformación digital y los errores que se pueden cometer tanto en la gestión del cambio como en la implementación de nuevas tecnologías, son factores que no sólo podrían reducir la

capacidad institucional para implementar cambios en materia tecnológica, sino que también podrían tener efectos contradictorios en las dimensiones económica y social de la estrategia de sostenibilidad de la Universidad.

Una vez diseñado el modelo de transformación digital, el Análisis Factorial Confirmatorio (AFC), permitió comprobar que se ajustaba satisfactoriamente a los datos, logrando así una validación empírica ya que, al analizar los parámetros estimados para cada coeficiente, se observó que todos ellos poseían una magnitud importante ($\lambda > 0{,}5$), interpretándose que contribuyen significativamente a la explicación de la respectiva variable latente y demostrándose que todas las variables formaban un constructo robusto que explicaban el fenómeno estudiado, por lo que el modelo de transformación digital de la Universidad Autónoma de Chile resultó adecuado e intrínsecamente validado por los datos. Sin embargo, y ante las limitaciones en cuanto al tamaño de la muestra, el modelo analizado no es susceptible de generalización ya que sólo constituye la representación de una realidad que se circunscribe al contexto en el que se recogieron los datos.

Con respecto a la forma cómo la transformación digital de la Universidad impacta en la satisfacción del estudiante, y luego de aplicar la técnica de modelado de ecuaciones estructurales tomando como referencias el Modelo de Transformación Digital (previamente validado) y el Modelo de Índice de Satisfacción del Estudiante, propuesto por Turkyilmaz *et al*. (2018), se infiere que la *calidad percibida* por los estudiantes es la variable que mayor efecto tiene sobre la satisfacción. Al mismo tiempo se halló que las *expectativas* creadas respecto a los resultados de la transformación digital de la Universidad influyen de forma negativa en la satisfacción; es decir, que mientras mayores sean las expectativas creadas con respecto a la transformación digital más difícil será satisfacer a los estudiantes y lograr su lealtad con la institución. Este hallazgo se desvía de los postulados de Turkyilmaz *et al*. (2018) y parece ser uno de los aspectos más sensibles al momento de iniciar un proceso de transformación digital a gran escala.

La *calidad percibida* se refiere a la evaluación que los estudiantes hacen de sus experiencias recientes en la Universidad, incluyendo la calidad educativa que perciben, la contribución del entorno social para alcanzar la meta, la excelencia gerencial y administrativa, y el cumplimiento de las metas educativas y profesionales. Los resultados del análisis coinciden con los creadores del modelo de Índice de Satisfacción del Estudiante, quienes argumentan que la calidad percibida influye de manera positiva en la

satisfacción de los estudiantes, al igual que el valor percibido, entendido este como el nivel de calidad del servicio que los estudiantes perciben en relación con el precio que pagan.

Ahora bien, a pesar de que los datos demuestran que la satisfacción del estudiante de la Universidad Autónoma de Chile, desde una perspectiva de Transformación Digital, es causada por la *Calidad percibida*, el *Valor percibido*, las *Expectativas del estudiante* y la *Imagen de la Universidad*, se puede interpretar que el nivel de satisfacción alcanzado por el estudiante está influenciado por aspectos subjetivos que toman en cuenta tanto las experiencias del pasado como las expectativas del futuro, De igual modo, la satisfacción no solo depende de la forma como el estudiante percibe la calidad de la educación, la efectividad de los modelos pedagógicos, las capacidades de los docentes y la calidad de los servicios que recibe, sino que, además, en su valoración también intervienen las percepciones del estudiante sobre la imagen de la Universidad en el contexto académico y social, la cual puede repercutir en las posibilidades de acceder al mercado de trabajo.

Desde esta perspectiva, los resultados obtenidos demuestran el impacto potencial de la transformación digital de la Universidad Autónoma de Chile en la satisfacción de los estudiantes. Por supuesto, este proceso de transformación requiere educar a los docentes y estudiantes en competencias digitales, así como incorporar profundos cambios en la gestión de la Universidad, de manera tal que pueda adaptarse con agilidad a los constantes desafíos que plantea un entorno digital caracterizado por los continuos cambios y las cada vez mayores exigencias sociales.

En todo caso, los resultados obtenidos refuerzan la idea de que la única justificación para implantar el modelo de transformación digital es poner las capacidades tecnológicas de la Universidad al servicio de los estudiantes y los docentes.

Por otra parte, los resultados obtenidos en esta investigación demuestran que la satisfacción del estudiante y la imagen de la Universidad impactan en la lealtad, siendo la satisfacción la más relevante. Sobre este particular conviene destacar que la calidad percibida es la variable que mayor efecto tiene sobre la satisfacción del estudiante, por lo que la transformación digital de la Universidad deberá generar cambios importantes y tangibles en todos los procesos involucrados.

Por último, se pudo demostrar que un requisito del que no se puede prescindir para lograr un buen nivel de *Lealtad* de los estudiantes hacia la institución educativa es mantener altos niveles de *Satisfacción*. Esto conduce a entender que la verdadera transformación digital de la Universidad Autónoma de Chile no se refiere a un simple proceso de digitalización de sus procesos, o a la aplicación de tecnologías de aprendizaje online, sino que demanda una serie de cambios profundos y coordinados que sustenten nuevos modelos de enseñanza y aprendizaje, y que sean capaces de sustentar los procesos internos y las orientaciones estratégicas de la Universidad.

Consecuentemente se interpreta que el propósito de la transformación digital es ofrecer a los estudiantes una nueva propuesta de valor, acorde con las características del contexto tecnológico, económico y social. Todo ello en un marco que salvaguarde los principios éticos y reduzca la desigualdad de oportunidades formativas y laborales.

En síntesis, utilizando como referencia el modelo de índice de satisfacción de los estudiantes que fue creado por Turkyilmaz *et al*., (2018) y empleando un sistema de ecuaciones estructurales, se pudo demostrar el impacto potencial de la transformación digital de la Universidad Autónoma de Chile en la satisfacción de los estudiantes y en su lealtad hacia la institución. No obstante, los resultados obtenidos no son extrapolables a otros contextos universitarios ya que el modelo de transformación digital fue diseñado específicamente para esta Universidad, luego de considerar sus particularidades culturales y estructurales.

En todo caso, a la vista de la indiscutible relación entre transformación digital y satisfacción estudiantil, queda pendiente la profundización de este objeto de estudio en lo referente a la utilización de las tecnologías digitales de la Universidad para la promoción de valores humanísticos, como la inclusión, la justicia y la igualdad, entendidos estos como factores que favorecen el mejoramiento de la condición humana, y determinar su impacto en los niveles de satisfacción de la comunidad estudiantil. De igual manera, convendría analizar las repercusiones de la transformación digital de la Universidad en los procesos de toma de decisiones en los que los estudiantes se encuentran involucrados.

Finalmente, a modo de reflexión, el diseño del modelo de transformación digital de la universidad y su impacto en la satisfacción del estudiante, verifica lo que Xiao (2019) ha destacado cuando sostiene que la digitalización, tal como la perciben las universidades de China y otros países, parece estar orientada a la creación instrumental de campus digitales

y al desarrollo de innovaciones en los procesos académicos, pero carecen de incentivos suficientes para que las tecnologías digitales mejoren la capacidad de investigación y sirvan a una comunidad más amplia. De hecho, durante el proceso de recogida de datos en esta investigación, ninguno de los expertos consultados mencionó la mejora de la actividad científica, la cual debe ser entendida como una de las actividades sustantivas de las universidades. Este aspecto tampoco se reflejó en ninguno de los modelos que sirvieron de base para construir el modelo teórico de transformación digital de la Universidad Autónoma de Chile.

Las anteriores circunstancias ameritan la realización de nuevos estudios orientados a determinar las razones por las cuales, en el caso de la educación superior, dicho proceso de transformación parece estar delimitado de manera predominante al contexto académico interno y deja de lado la investigación y la vinculación con la sociedad, entendidas ambas como funciones sustantivas de la Universidad.

En este sentido, en el ámbito del gobierno de TI, como dimensión del proceso de transformación que más contribuye a la madurez digital de la Universidad (21,96%), es necesario dilucidar de qué manera la estructura digital de la institución permite alinear las necesidades técnicas, logísticas y estratégicas con la redefinición de los roles del personal administrativo, docente y de los estudiantes; todo ello con el fin de promover la innovación continua de servicios y procesos, y crear nuevos espacios de aprendizaje digital centrados en los estudiantes, siendo pertinente, en este caso, intentar dilucidar cuáles son los potenciales problemas y las necesidades que surgen en cuanto a las nuevas interacciones tecnológicas que tendrán lugar dentro de la Universidad, así como la identificación de las nuevas oportunidades que ofrecen dichos vínculos en el contexto de la Responsabilidad Social Universitaria.

7. CONCLUSIONES

Una vez finalizada la investigación y habiéndose discutido los hallazgos se llega a las siguientes conclusiones:

En cuanto al análisis bibliométrico realizado sobre los procesos de transformación digital, se evidencia la escasa producción científica sobre esta materia en el contexto de la educación superior, estando principalmente concentrada en Europa, Estados Unidos,

China y Rusia. Al respecto, no se han encontrado estudios en profundidad que aborden la transformación digital en universidades del contexto latinoamericano, siendo esta la primera investigación que, mediante un sistema de ecuaciones estructurales, logra validar un modelo de transformación digital diseñado expresamente para la Universidad Autónoma de Chile, y determina el impacto potencial de dicho modelo en la satisfacción de los estudiantes.

En referencia a la Ley de Lotka, que revela la concentración de publicaciones por autor, se evidencia una escasa colaboración entre los autores más prolíficos en términos de coautoría, ya que solo hay 16 autores que publican más de tres artículos sobre esta materia no existiendo relación entre ellos. Complementando lo anterior, pero considerando la Ley de Hirsch, los autores con más citas se encuentran en España, representando a la Universidad de Almería, con 115 citas cada uno en WoS, siendo importante destacar la alta concentración de documentos en la revista "Sustentabilidad", que alcanza el 33,3% de las publicaciones, junto con una concentración del 44,4% a nivel editorial. En cuanto a la Ley de Zipf, se pudieron observar tres grupos de palabras claves fuertemente utilizadas; estas son: *Modelo*, *Estudiantes* y *Tecnología*, vinculadas a: “la modernización en la educación superior en pandemia”, “los efectos del proceso de digitalización en los estudiantes” y el “proceso de digitalización en educación superior”, respectivamente.

Otra de las principales conclusiones que se extraen del estudio bibliométrico es la poca investigación realizada sobre la digitalización en las instituciones de educación superior, siendo notorio el aumento exponencial de la producción científica en temas de transformación digital en diferentes áreas a partir del 2019, cuyo principal impulsor fue probablemente la pandemia de Covid-19. No obstante, este dato no necesariamente confirma el interés por la transformación digital vista desde una perspectiva sistémica, sino que pudiera estar influenciado por la urgente necesidad de adoptar nuevas tecnologías que tan solo permitieran aprovechar los recursos tecnológicos existentes para eliminar la presencialidad en el aula de clases, lo cual, obviamente, no es un indicativo de transformación digital tal como ha sido conceptualmente concebida para los efectos de esta investigación.

Por otra parte, luego de considerar las dimensiones y factores que los estudiantes y docentes calificaron como esenciales para la transformación digital de la Universidad, se puede afirmar que:

1. Todas las variables del modelo y sus correspondientes dimensiones (nueve en total) forman un constructo robusto que explica el proceso de transformación digital de la Universidad Autónoma de Chile, habiendo sido intrínsecamente validado por los datos.

2. La madurez digital de la Universidad Autónoma de Chile está determinada, principalmente, por la forma de utilizar los recursos tecnológicos (40,53%), por su capacidad para integrar las diferentes tecnologías (38,77%) y, en menor medida, por los recursos digitales que posea (20,68%).

3. El foco en la experiencia del estudiante, junto con las habilidades y capacidades de la Universidad para gestionar la tecnología, son las dos dimensiones más relevantes en el proceso de transformación digital de la Universidad Autónoma de Chile. Sorprendentemente, los recursos financieros representan la dimensión que menos aporta a este proceso, tal como se reveló en el Análisis Factorial Confirmatorio.

4. La madurez digital es una variable estrechamente interrelacionada con el proceso de transformación digital de la Universidad, en la que influyen: (1) las habilidades y capacidades para gestionar la tecnología; (2) el uso y explotación de la base tecnológica; y (3) la cultura organizacional y el enfoque estratégico de la institución.

5. Los factores que facilitan el proceso de transformación digital en la Universidad son: (1) el enfoque en el estudiante; (2) el aprendizaje permanente y el compromiso demostrado por las entidades responsables de llevar a cabo dicho proceso; y (3) la coordinación y gestión efectiva de los procesos en las áreas involucradas.

6. En sentido contrario, los principales factores que podrían obstaculizar la implementación del proceso de transformación digital en la Universidad Autónoma de Chile son: (1) la falta de liderazgo y poca visión a largo plazo; (2) lentitud en los procesos de toma de decisiones; (3) amplia brecha generacional entre profesores y estudiantes; y (4) poca inversión en la base tecnológica.

Finalmente, partiendo de la premisa de que el propósito de la transformación digital es ofrecer a los estudiantes una nueva propuesta de valor, acorde con las características del

contexto tecnológico, económico y social, se demostró que la transformación digital de la Universidad Autónoma de Chile impacta en la satisfacción de los estudiantes y en su lealtad hacia la institución.

Finalizada la exposición de las conclusiones, a continuación, se presentan algunas sugerencias dirigidas tanto a la comunidad científica como a los entes responsables de llevar a cabo el proceso de transformación digital de la Universidad. Al respecto, dada la baja producción científica en el campo de la transformación digital en el contexto universitario se plantea la inquietud de proponer nuevos constructos que sirvan para implementar y controlar los procesos de transformación en las instituciones de educación superior, de manera tal que conduzcan a aumentar los niveles de madurez digital que impactan directamente en la satisfacción estudiantil.

De igual manera, considerando que modelo analiza 54 indicadores y que el tamaño ideal de la muestra debe contener entre 10 y 20 casos por cada indicador (Thompson, 2004) sería pertinente replicar este estudio utilizando el mismo modelo teórico, pero aumentando el volumen de datos a un mínimo de 540 casos. Aun así, el modelo de transformación digital de la Universidad Autónoma de Chile no será susceptible de generalización ya que sólo constituye la representación de una realidad que se circunscribe al contexto en el que se recogieron los datos.

Por otro lado, se recomienda incrementar el número de indicadores en la dimensión 'Recursos Financieros' hasta un mínimo de tres variables. De esta manera, para realizar el Análisis Factorial Confirmatorio se podrá utilizar el método de Máxima Verosimilitud o el método de Mínimos Cuadrados Generalizados, los cuales son más robustos que el método de Mínimos Cuadrados No Ponderados que fue empleado en esta investigación.

Manteniendo el interés en la perspectiva científica, a la luz de los hallazgos surgen dos áreas de posibles investigaciones relacionadas con: (1) la influencia de las rutinas organizacionales en la adopción de una cultura organizacional acorde con las demandas del ecosistema digital en el contexto de la educación superior, y (2) el impacto potencial de la transformación digital en sostenibilidad de la Universidad. Estas dos líneas de investigación permitirán profundizar el conocimiento sobre este objeto de estudio, a la par de proveer pautas de actuación que permitan aprovechar el valor de las tecnologías digitales, desarrollar modelos de referencia de procesos y acelerar la puesta en marcha de

un enfoque dirigido a mejorar la experiencia del estudiante, involucrando para ello a toda la organización.

Por último, desde una perspectiva no científica, se sugiere que los responsables de gestionar la implementación del modelo de transformación digital en la Universidad consideren la influencia de las relaciones de poder durante el proceso de transición hacia la transformación digital, ya que esto afectará la coordinación de los procesos internos asociados a la gobernanza de la información, las formas de actuar de las personas con responsabilidades técnicas y de gestión, el desempeño de los docentes y la confianza de los estudiantes sobre los futuros procesos académicos y administrativos.

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ANEXOS

ANEXO I

Cuestionario F1 / Dimensiones y factores involucrados en la transformación digital de una universidad

Gracias por acceder a este cuestionario destinado a conocer sus apreciaciones sobre los distintos elementos que intervienen en la transformación digital de una Universidad.

Para efectos de esta investigación, la transformación digital es el proceso de gestión que orienta la cultura, la estrategia, las metodologías y las capacidades de una organización a partir del uso de las tecnologías digitales (Crespo y Pariente, 2018).

Este cuestionario consta de tres partes:

En la primera parte se le pedirá información general sobre su perfil (género, nivel académico alcanzado y disciplina en la que desarrolla sus actividades)

En la segunda parte se presentan 11 dimensiones con sus correspondientes definiciones. Se le pedirá su opinión sobre la importancia de cada una de ellas para gestionar la transformación digital de una Universidad.

Finalmente, en la tercera parte encontrará los factores teóricamente implícitos en cada una de esas dimensiones. Al igual que en la sección anterior, solicitamos que nos diga cuál es su apreciación sobre la importancia de cada uno de ellos para gestionar la transformación digital de una Universidad.

Sus respuestas serán fundamentales para el buen desarrollo de esta investigación, por lo que de antemano agradecemos la sinceridad de sus opiniones y el tiempo destinado para tal fin.

Para comenzar a responder el cuestionario, por favor haga clic en el botón SIGUIENTE

SECCIÓN 1: DATOS GENERALES

Por favor, seleccione la opción que mejor le defina

1.1 Género

- ○ Femenino
- ○ Masculino
- ○ Otro

1.2 Nivel académico

- ○ Estudiante Universitario (nivel pregrado)
- ○ Otro nivel académico

1.3 Área disciplinar a la que pertenece

- ○ Administración y Economía
- ○ Arquitectura, Construcción y Medio Ambiente
- ○ Ciencias de la Salud
- ○ Educación
- ○ Informática
- ○ Ingeniería
- ○ Otro

SECCIÓN 2: VALORACIÓN DE LAS DIMENSIONES INVOLUCRADAS EN LA TRANSFORMACIÓN DIGITAL DE UNA UNIVERSIDAD

A continuación, encontrará 11 dimensiones con sus respectivas definiciones. Por favor, indique su valoración sobre el grado de importancia de cada una de ellas para gestionar la transformación digital de una universidad.

2.1 Marco Estratégico Institucional enfocado a la transformación digital

Se refiere a una estrategia integral enfocada al servicio entregado por la universidad e impulsada por lo digital, que involucra todos los procesos generadores de valor en el largo, mediano y corto plazo. Implica adaptar la estrategia corporativa, de negocio y funcional a una modalidad digital (Crespo y Pariente 2018).

SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE

2.2 Cultura digital

Facilita cambiar el paradigma tradicional de la Comunidad Educativa Universitaria hacia un enfoque digital en donde exista una mejor disposición para el empleo de las tecnologías de información y comunicación. Se refiere a la forma de enfocar los procesos de aprendizaje y gestión educativa. Posibilita que los estudiantes, profesores, administrativos y apoderados se familiaricen con lo digital por medio de la capacitación (Gobble, 2018).

SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE

2.3 Organización y Estructura

Forma de organizar las funciones dentro de la Universidad, incluyendo los roles y responsabilidades, talento y aprendizaje, forma de gobernanza, liderazgo TI, forma de diseñar el trabajo y adaptarlo por medio de las Tics (Crespo y Pariente, 2018).

SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE

2.4 Capacidades críticas y recursos claves

Capacidades y recursos orientados a digitalizar los aspectos que generan valor dentro de la organización y que son fuentes de ventajas competitivas como la conectividad, experiencia del cliente, toma de decisiones a partir de los datos, automatización y arquitectura TI (McKinsey, 2014, 2015).

SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE

2.5 Ciclo de vida del estudiante *(compromiso con la universidad)*

Se refiere a los nuevos beneficios que se obtienen al mejorar la experiencia del estudiante a través de la transformación digital (Valdez-de León, (2016). Involucra el paso del estudiante por la Universidad, incluyendo la promoción, campañas de captación, matrícula, docencia, búsqueda de empleo y seguimiento de exalumnos.

SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE

2.6 Ecosistema (socios y aliados estratégicos que debiera tener una Universidad)

Se refiere al desarrollo de una red estratégica de aliados como un elemento clave para ofrecer soluciones integrales al estudiante (Valdez-de León, 2016).

SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE

2.7 Enseñanza flexible y personalizada

Desde una docencia de talla única a una docencia a la medida, manejando la información individualizada del estudiante a través del análisis de datos predictivos para ofrecer sistemas de asesoramiento individualizados (Salinas, J. 2013).

SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE

2.8 Puntos de contacto con el estudiante

Los estudiantes requieren ser atendidos en cualquier momento, desde cualquier lugar y en cualquier dispositivo (Furedi, 2011). Se deben digitalizar los puntos de servicio.

SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE

2.9 Redes sociales e investigación de perfiles

Esta dimensión involucra el marketing educativo, la captación de nuevos estudiantes y el análisis de la *tasa de clics*, la cual es una medida de marketing digital para evaluar el rendimiento de los contenidos en Internet (ya sea en Google o en RR. SS), entender la percepción de nuestro público frente a los programas académicos de mi universidad, identificar puntos de mejora en el servicio y crear nuevos programas para responder a las necesidades (De Haro, J.J. 2010).

SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE

2.10 Procesos de Transformación de la Docencia para la Educación Superior

Transformar la docencia para la educación digital, transformando las dinámicas de enseñanza y aprendizaje (Valdez-de-León, 2016).

SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE

2.11 Inversión en Tecnologías de Información (TI)

Involucra un soporte técnico adecuado para la Universidad, digitalización de máquinas físicas y virtualización. De lo análogo a lo digital (McKinsey, 2014-2015).

SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE

SECCIÓN 3: VALORACIÓN DE FACTORES INVOLUCRADOS EN LA TRANSFORMACIÓN DIGITAL DE UNA UNIVERSIDAD (por dimensión)

A continuación, encontrará un conjunto de factores relacionados con las dimensiones involucradas en la transformación digital de una universidad. Para cada una de ellas, por favor indique su valoración sobre el grado de importancia para gestionar la transformación digital de una universidad

3.1 Dimensión: "Marco Estratégico Institucional"

FACTORES ASOCIADOS A LA DIMENSIÓN	SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE
Misión y Visión, enfocada a lo digital					
Objetivos estratégicos con enfoque en TI (tecnologías de información)					
Posicionamiento a través de plataformas digitales					
Estrategias de fidelización de estudiantes con enfoque digital					
Iniciativas digitales alineadas con la estrategia corporativa					

3.2 Dimensión: "Cultura Digital"

FACTORES ASOCIADOS A LA DIMENSIÓN	SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE
Capacitación con enfoque en tecnologías digitales					
Impulso a proyectos en temáticas digitales					
Tolerancia a los cambios					
Habilidad de aprendizaje continuo					
Enfoque integral en la experiencia del estudiante					

3.3 Dimensión: "Organización y Estructura"

FACTORES ASOCIADOS A LA DIMENSIÓN	SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE
Tecnologías digitales presentes en procesos organizacionales					
Procesos administrativos digitalizados					
Tecnologías digitales en flujos de trabajo					
Estructura organizacional adaptable a lo digital					
Toma de decisiones incorporando TI					

3.4 Dimensión: "Capacidades Críticas y Recursos Claves"

FACTORES ASOCIADOS A LA DIMENSIÓN	SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE
Toma de decisiones guiadas por datos					
Enfoque TI en fidelización de estudiantes y marca universidad					
Solución de problemas a estudiantes, con enfoque TI					
Tecnologías en optimización del back – office de la organización					
Servicios accesibles en todo lugar y momento					

3.5 Dimensión: "Ciclo de Vida del estudiante" *(Compromiso con la Universidad)*

FACTORES ASOCIADOS A LA DIMENSIÓN	SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE
Digitalización del ciclo de vida del estudiante					
Incorporación de TI para satisfacción y retención del estudiante					
Acompañamiento académico y pedagógico con enfoque en TI					
Prácticas laborales y búsqueda de empleo con enfoque digital					
Incorporación de TI para continuidad de estudios					

3.6 Dimensión: "Ecosistema" (socios y aliados estratégicos que debiera tener una Universidad)

FACTORES ASOCIADOS A LA DIMENSIÓN	SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE
Relaciones con empresas y corporaciones					
Relaciones con comunidades y grupos sociales					
Redes con Fundaciones/ONG					
Relaciones con universidades internacionales					
Vínculos con la comunidad educativa y profesores de otras universidades					

3.7 Dimensión: "Enseñanza flexible y personalizada"

FACTORES ASOCIADOS A LA DIMENSIÓN	SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE
Incorporación de TI en el ritmo de estudio del alumno					
Modelo de enseñanza adecuado al lugar físico del alumno					
Utilización de datos predictivos para anticipar las necesidades del alumno					
Sistema de asesoramiento individualizado					
Adecuación de enseñanza al perfil de cada estudiante					

3.8 Dimensión: "Puntos de contacto con el estudiante"

FACTORES ASOCIADOS A LA DIMENSIÓN	SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE
Biblioteca digitalizada					
Plataforma digital para asuntos estudiantiles					
Apoyo TI para fomentar grupos de trabajo					
Apoyo digital a la relación estudiante-director de carrera-secretaría					

3.9 Dimensión: "Redes Sociales e Investigación de Perfiles"

FACTORES ASOCIADOS A LA DIMENSIÓN	SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE
Análisis de indicadores de posicionamiento					
Análisis de percepciones de estudiantes en RRSS					
Identificación de puntos de mejora en los servicios digitales					
Captación de estudiantes potenciales a través de las redes sociales					
Fomento de aprendizaje colaborativo en RRSS					

3.10 Dimensión: "Procesos de Transformación de la Docencia para la Educación Superior"

FACTORES ASOCIADOS A LA DIMENSIÓN	SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE
Aplicación de TICs en el proceso de enseñanza-aprendizaje					
Capacitación en estrategias pedagógicas digitales					
Integración proyecto de vida alumno - estrategia de enseñanza					
Incorporación de estrategias digitales de enseñanza en procura de la integración familiar					
Integración nivel socioeconómico del alumno con estrategias de enseñanza digitales					

3.11 Dimensión: "Inversión en TI"

FACTORES ASOCIADOS A LA DIMENSIÓN	SIN IMPORTANCIA	POCO IMPORTANTE	NEUTRAL	IMPORTANTE	MUY IMPORTANTE
Inversión en plataformas de aprendizaje					
Soporte técnico de calidad en procesos digitales					
Automatización de servicios docentes dirigidos a sus estudiantes					
Inversión en plataformas tecnológicas administrativas					
Mejora de puntos de contacto con estudiantes a través de TICs					

ANEXO II

Guion de entrevista semiestructurada / Directivos y expertos

Género: ___Masculino ___ Femenino ___Otro

Nivel de estudios: __Doctorado ___Magíster ___Licenciatura ___Técnico ___Diplomado

Área disciplinar:

__Educación __Ciencias de la Salud __Ingeniería __Derecho __Administración y Negocios

__Arquitectura, Construcción y Medio Ambiente __Informática __Otra

1. ¿Según su opinión, cuáles son las áreas más susceptibles de ser digitalizadas para agregar valor a la universidad y a sus estudiantes?
2. De las áreas que ha nombrado, ¿cuál sería para usted la más importante y por qué?
3. Según su opinión ¿qué actividades desarrolladas en la Universidad producirán un mayor impacto en la satisfacción del estudiante al ser digitalizadas?, ¿pudiera brevemente describir el impacto que produciría?
4. Como sabe, estamos diseñando un modelo teórico para medir el grado de madurez digital de una universidad. Según su experiencia ¿cuáles cree usted que son los factores que determinan ese grado de madurez?
5. Entendemos que muchas universidades aún no han iniciado un proceso de modernización orientado a su trasformación digital ¿Cree usted que actualmente están dadas las condiciones para que las universidades chilenas inicien ese proceso?
6. ¿Cuál cree usted que es el área que debiera liderar los proyectos de transformación digital en una Universidad?
7. ¿Según su punto de vista, cuáles son los motivos que pudieran impulsar la transformación digital de una universidad?, ¿habría diferencias entre universidades públicas y privadas?
8. Y en sentido contrario, ¿cuáles son las razones que pudieran dificultar esa transformación, ¿habría diferencias entre universidades públicas y privadas?
9. ¿De qué manera cree usted que se pudiera potenciar la innovación y la integración de tecnologías digitales en las diversas áreas de la universidad?
10. ¿Desea añadir algún otro comentario o reflexión sobre el posible impacto de la transformación digital en las universidades chilenas?

ANEXO III

Aplicación del modelo de Lawshe / Validez de contenido - Cuestionario F1

Coeficiente de Razón de Validez

SECCIÓN 1	Ex1	Ex2	Ex3	Ex4	Ex5	Ex6	Ex7	Ex8	Ex9	Ex10	Ex11	Ex12	Ex13	Ex14	Ex15	Ex16	Ex17	Ex18	Ex19	Ex20	Ex21	Ex22	Ex23	Ex24	Ex25	Ex26	Ex27	Ex28	Ex29	Ex30	Ex31	Ex32	Ex33	Ex34	Ex35	Ex36	Ex37	Ex38	Ex39	Ex40	Esenciales (n_e)	CVR	CVR´
D1	3	3	3	3	3	3	2	3	3	3	3	1	3	3	2	3	2	3	2	3	2	1	2	2	3	3	3	3	2	3	3	3	2	3	2	3	2	3	3	2	26	0,30	0,650
D2	3	3	3	2	3	2	3	3	3	3	3	2	3	3	3	2	3	2	3	3	2	3	2	2	3	3	3	2	3	3	3	3	3	3	3	2	3	3	3	3	31	0,55	0,775
D3	3	2	3	2	3	2	2	3	3	3	3	3	2	3	2	3	3	3	2	3	3	3	3	3	3	2	2	2	3	3	3	3	2	3	3	2	2	3	3	3	27	0,35	0,675
D4	3	3	3	3	3	3	3	3	2	3	3	2	3	3	2	3	2	3	2	3	2	2	2	2	2	2	2	2	2	3	3	3	3	2	2	3	3	2	3	3	24	0,20	0,600
D5	3	3	3	2	3	2	3	3	2	3	3	2	2	3	3	2	3	3	2	3	3	1	2	1	3	1	3	3	3	2	3	3	3	3	3	2	2	2	3	3	25	0,25	0,625
D6	3	2	3	1	3	3	3	3	2	3	3	2	2	3	3	3	3	3	3	2	2	2	2	3	3	1	3	2	2	2	3	3	2	3	2	1	2	2	3	2	21	0,05	0,525
D7	3	2	2	3	3	3	2	3	3	3	3	2	2	3	2	1	3	3	3	2	3	3	3	2	3	2	2	2	2	2	3	3	3	3	2	3	3	3	3	3	25	0,25	0,625
D8	2	2	3	3	3	1	1	3	3	3	3	2	2	3	3	2	3	3	2	2	3	1	2	3	3	3	3	3	3	3	3	3	2	2	3	3	3	2	2	3	25	0,25	0,625
D9	3	3	2	3	3	3	3	3	3	3	3	2	2	3	3	2	3	2	3	2	2	2	2	2	2	3	2	3	3	3	2	3	3	3	2	3	3	1	2	3	24	0,20	0,600
D10	3	3	3	2	3	3	2	3	3	3	3	2	2	3	3	2	2	3	2	3	3	1	3	2	3	3	3	2	3	3	3	3	3	3	3	3	3	2	3	3	29	0,45	0,725
D11	3	3	3	3	3	3	2	3	3	3	3	2	3	3	3	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	2	34	0,70	0,850

SECCIÓN 2	Ex2	Ex3	Ex3	Ex4	Ex5	Ex6	Ex7	Ex8	Ex9	Ex10	Ex11	Ex12	Ex13	Ex14	Ex15	Ex16	Ex17	Ex18	Ex19	Ex20	Ex21	Ex22	Ex23	Ex24	Ex25	Ex26	Ex27	Ex28	Ex29	Ex30	Ex31	Ex32	Ex33	Ex34	Ex35	Ex36	Ex37	Ex38	Ex39	Ex40	Esenciales (n_e)	CVR	CVR´
D1-F1	2	3	1	3	3	3	3	3	3	3	3	1	3	1	2	2	3	2	3	3	3	1	3	2	3	2	3	3	3	3	3	3	2	3	3	3	3	2	2	3	26	0,30	0,650
D1-F2	3	3	1	3	3	3	3	3	2	3	3	2	3	1	2	3	2	3	2	3	3	2	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	31	0,55	0,775
D1-F3	3	3	2	2	3	3	2	3	2	3	3	2	3	1	3	3	3	3	2	3	3	3	3	2	2	3	3	2	3	3	3	3	3	2	3	2	3	3	3	2	27	0,35	0,675
D1-F4	3	3	3	3	3	2	2	3	3	3	3	2	3	1	3	3	3	3	2	3	3	2	2	2	2	3	3	3	2	3	2	3	3	3	2	3	3	3	3	2	27	0,35	0,675
D1-F5	2	3	3	3	3	3	3	3	3	3	3	2	2	1	3	2	3	3	2	3	2	1	3	3	3	3	3	3	2	3	3	2	2	3	3	3	3	3	3	3	29	0,45	0,725
D2-F1	3	3	2	3	3	3	3	3	3	3	3	2	3	3	2	3	3	3	2	3	3	2	3	2	3	3	3	2	3	3	3	3	3	3	3	2	3	3	3	3	31	0,55	0,775
D2-F2	3	3	2	3	2	3	3	3	3	3	3	2	3	3	2	3	3	3	2	3	3	3	3	3	3	3	3	2	3	3	3	3	3	2	3	3	2	3	3	3	33	0,65	0,825
D2-F3	2	2	3	2	3	3	3	3	3	3	3	3	3	2	2	3	3	3	3	2	2	3	3	2	3	2	3	3	3	3	3	3	3	3	3	3	3	3	2	2	29	0,45	0,725
D2-F4	3	2	3	1	3	2	3	3	2	3	3	2	3	3	2	1	3	3	3	3	2	1	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	2	29	0,45	0,725
D2-F5	3	2	3	2	3	2	3	3	3	3	3	2	3	2	2	3	3	3	3	3	2	3	2	3	2	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	31	0,55	0,775
D3-F1	3	2	3	3	3	3	1	3	3	3	3	2	3	3	3	3	3	2	3	3	2	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	33	0,65	0,825
D3-F2	3	2	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3	3	3	2	2	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	2	34	0,70	0,850
D3-F3	2	2	3	2	3	3	3	3	2	3	3	2	3	3	2	2	3	2	3	3	3	1	2	2	3	3	3	2	3	3	3	3	3	3	2	3	3	3	3	3	27	0,35	0,675
D3-F4	3	2	2	2	3	3	1	3	3	3	3	3	3	3	2	2	3	3	2	3	2	2	3	1	3	2	3	3	3	3	3	3	3	2	2	3	3	3	3	3	27	0,35	0,675
D3-F5	3	2	3	2	1	3	3	3	3	3	3	2	3	3	2	2	3	3	2	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	2	3	3	3	3	3	31	0,55	0,775
D4-F1	3	2	3	3	2	3	3	3	2	3	3	1	3	3	2	2	1	3	2	3	2	2	2	2	3	2	3	3	3	3	2	3	3	3	3	2	3	3	3	2	24	0,20	0,600
D4-F2	3	2	3	2	3	2	2	3	3	3	3	2	2	3	3	2	3	3	2	3	3	2	1	3	3	3	3	3	2	3	2	3	3	3	3	2	3	3	3	2	26	0,30	0,650
D4-F3	3	3	2	2	2	2	3	3	3	3	3	3	3	3	2	2	3	3	3	2	2	3	3	2	3	3	3	2	3	3	3	3	3	3	3	2	3	3	3	3	29	0,45	0,725
D4-F4	3	3	3	1	2	3	2	3	3	3	3	3	3	3	2	1	3	2	3	3	2	3	2	2	3	2	3	3	3	3	3	3	3	3	3	1	3	3	3	2	28	0,40	0,700
D4-F5	3	2	3	3	3	3	1	3	3	3	3	2	3	3	2	2	3	3	2	3	2	2	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	2	30	0,50	0,750
D5-F1	3	3	3	1	3	2	3	3	2	3	3	1	3	2	3	2	3	3	2	3	2	1	2	2	3	3	3	3	3	3	3	3	3	3	2	2	2	3	3	2	25	0,25	0,625
D5-F2	3	3	3	2	3	2	3	3	3	3	3	2	3	2	2	3	3	3	2	3	3	1	2	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	30	0,50	0,750
D5-F3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	2	3	2	3	3	3	3	2	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	35	0,75	0,875
D5-F4	3	2	3	3	2	3	2	3	3	3	3	2	3	3	3	2	3	3	2	3	3	2	2	2	3	3	3	3	2	3	2	3	3	3	3	2	3	3	3	3	28	0,40	0,700
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D6-F1	3	2	3	1	3	3	2	3	2	3	3	2	2	2	2	2	3	3	2	3	2	2	2	2	3	2	3	2	3	2	3	3	3	3	2	1	3	2	3	2	19	-0,05	0,475
D6-F2	3	1	3	1	2	2	2	3	2	3	3	2	1	3	3	1	3	3	2	3	1	3	3	2	3	3	2	2	3	3	3	2	3	3	2	1	3	2	3	2	21	0,05	0,525
D6-F3	3	1	3	2	2	2	2	3	2	3	3	3	2	3	2	2	3	3	2	3	3	1	2	2	2	3	3	2	2	3	3	3	2	3	3	2	1	3	2	3	19	-0,05	0,475
D6-F4	3	1	3	2	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	2	3	3	3	3	2	3	3	3	3	3	3	2	3	3	3	3	3	33	0,65	0,825
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D7-F1	3	3	3	3	3	3	1	3	3	3	3	2	3	3	2	2	3	3	2	3	3	2	2	2	3	3	3	2	3	3	3	3	3	3	2	3	3	3	2	2	29	0,45	0,725
D7-F2	3	3	3	2	2	1	2	3	3	3	3	1	3	3	3	2	3	3	3	2	2	2	3	3	3	3	2	2	3	2	3	3	3	3	3	3	3	3	3	2	27	0,35	0,675
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D7-F5	3	2	3	3	3	2	2	3	3	3	3	2	3	3	2	3	2	3	2	2	2	3	3	3	3	2	3	2	3	3	3	2	3	3	2	2	3	3	3	3	27	0,35	0,675
D8-F1	3	3	3	3	3	3	3	3	3	3	3	1	3	3	2	3	3	3	2	3	2	2	2	2	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	2	31	0,55	0,775
D8-F2	3	3	3	3	3	3	2	3	3	3	3	2	3	3	3	3	3	3	2	2	2	1	3	2	3	2	3	3	3	3	3	3	3	3	2	3	3	3	3	3	31	0,55	0,775
D8-F3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	2	3	3	3	2	3	3	2	2	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	34	0,70	0,850
D8-F4	2	1	2	3	2	2	2	3	2	3	3	1	2	3	2	2	3	3	2	2	3	3	3	2	2	2	2	2	3	3	2	3	1	3	3	3	1	1	2	2	15	-0,25	
D8-F5	3	1	3	3	3	2	2	3	2	3	3	3	3	3	3	3	3	3	2	3	3	1	2	3	3	3	3	2	3	3	3	2	3	3	3	2	3	3	3	2	29	0,45	0,725
D9-F1	3	3	3	3	2	2	3	3	3	3	3	2	3	3	3	2	3	3	3	3	3	1	2	2	3	2	3	2	3	3	3	3	3	3	3	2	3	2	3	3	28	0,40	0,700
D9-F2	3	3	3	3	3	2	2	3	3	3	3	1	3	3	3	3	2	3	3	3	2	2	2	2	3	3	3	2	3	3	2	3	2	3	3	2	3	2	3	2	26	0,30	0,650
D9-F3	3	3	3	3	3	3	2	2	3	3	3	2	3	3	3	3	3	3	3	3	2	3	3	2	3	3	3	3	3	3	3	3	3	3	2	2	2	3	3	3	32	0,60	0,800
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D9-F5	3	3	3	2	2	3	2	3	3	3	3	2	3	3	2	3	3	3	2	3	3	1	2	2	3	3	3	2	3	3	3	3	3	3	2	2	2	3	3	3	27	0,35	0,675
D10-F1	3	3	3	3	3	3	2	3	3	3	3	1	3	3	3	3	1	3	2	2	3	2	2	3	3	3	3	2	3	3	3	3	3	3	2	3	2	3	3	3	30	0,50	0,750
D10-F2	3	3	3	3	3	3	2	3	3	3	3	2	3	3	3	3	3	3	2	3	3	3	3	1	3	3	3	2	3	3	3	3	3	3	2	2	3	3	3	3	33	0,65	0,825
D10-F3	3	3	3	3	3	2	3	3	2	2	3	2	3	3	3	3	3	3	2	3	3	2	2	1	3	3	3	2	3	3	3	3	3	3	2	2	3	3	3	3	27	0,35	0,675
D10-F4	2	2	3	2	2	1	3	3	2	3	3	2	3	3	3	2	3	3	2	3	3	2	2	2	3	3	2	3	2	3	3	3	3	3	2	3	3	3	3	3	23	0,15	0,575
D10-F5	2	2	3	2	2	2	3	3	3	2	3	3	1	3	3	3	1	3	3	2	2	2	2	2	3	3	3	3	2	3	3	3	3	3	2	3	3	3	3	3	26	0,30	0,650
D11-F1	3	3	3	3	3	3	3	3	3	3	3	2	2	3	3	3	3	3	2	3	3	2	2	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	33	0,65	0,825
D11-F2	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	2	3	3	2	1	2	2	3	3	3	3	3	3	3	3	3	3	2	2	3	3	2	31	0,55	0,775
D11-F3	3	3	3	3	3	2	2	3	3	3	3	3	3	3	3	3	3	3	2	3	3	2	2	1	3	3	3	2	3	3	3	3	3	3	2	3	3	3	3	3	32	0,60	0,800
D11-F4	3	2	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	2	3	3	2	2	2	3	3	3	3	3	3	3	3	3	3	2	2	2	3	3	2	30	0,50	0,750
D11-F5	3	2	3	3	3	2	3	3	3	3	3	2	3	3	3	3	3	3	2	3	3	2	2	2	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	32	0,60	0,800

SECCIÓN 3	Ex2	Ex3	Ex3	Ex4	Ex5	Ex6	Ex7	Ex8	Ex9	Ex10	Ex11	Ex12	Ex13	Ex14	Ex15	Ex16	Ex17	Ex18	Ex19	Ex20	Ex21	Ex22	Ex23	Ex24	Ex25	Ex26	Ex27	Ex28	Ex29	Ex30	Ex31	Ex32	Ex33	Ex34	Ex35	Ex36	Ex37	Ex38	Ex39	Ex40	Fácilmente comprensible (n_f)	CVR	CVR´
D1	3	3	3	3	3	3	3	3	2	3	3	1	3	2	3	2	2	2	3	3	3	1	2	3	3	3	2	3	3	3	3	3	2	3	3	3	2	3	3	3	29	0,45	0,725
D2	3	3	3	3	3	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3	2	3	2	3	3	3	3	3	3	3	3	3	2	3	3	3	2	3	3	3	31	0,55	0,775
D3	3	3	3	3	3	3	3	3	3	3	3	1	3	2	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	2	3	3	3	3	3	3	2	3	3	3	35	0,75	0,875
D4	3	3	3	3	3	3	2	2	2	3	3	3	3	2	3	3	3	3	3	3	2	2	3	2	3	3	2	3	3	3	3	3	3	2	3	3	3	2	3	2	30	0,50	0,750
D5	3	3	3	3	3	3	2	3	2	3	3	2	3	2	3	3	3	3	3	3	2	1	3	3	3	3	2	2	3	3	3	3	3	3	2	2	3	3	3	3	30	0,50	0,750
D6	2	3	3	3	3	1	2	3	3	3	3	1	2	3	3	3	3	2	3	3	2	3	2	2	3	3	2	2	3	3	1	2	3	3	3	2	1	2	2	2	23	0,15	0,575
D7	3	2	3	3	3	2	3	3	3	3	3	3	3	2	3	2	3	3	3	3	3	3	3	2	3	3	2	3	3	3	3	3	2	3	2	3	2	3	3	3	31	0,55	0,775
D8	3	3	3	3	3	3	3	3	2	3	3	2	2	3	3	3	3	3	3	3	2	3	3	3	3	3	2	3	3	3	3	3	3	3	2	3	3	3	3	3	31	0,55	0,775
D9	3	3	3	3	3	3	2	3	3	3	3	1	3	2	3	2	3	3	2	3	3	1	3	2	3	3	2	2	3	3	3	3	3	2	3	2	3	3	3	2	28	0,40	0,700
D10	3	3	3	3	3	3	3	2	2	3	3	3	3	2	3	3	3	3	3	3	3	2	3	3	3	3	2	3	3	3	3	3	3	2	3	2	3	3	3	3	33	0,65	0,825
D11	3	3	3	3	3	3	3	3	2	3	3	2	3	2	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	2	3	2	3	3	3	34	0,70	0,850

ANEXO IV

Matriz de densidad (dimensiones y factores preliminares)

	[M1]	[M2]	[M3]	[M4]	[M5]	[M6]	[M7]	[M8]
1. Marco Estratégico Institucional enfocado a la transformación digital (Se integra a la dimensión 2: cultura digital)								
1.1. Misión y Visión, enfocada a lo digital.	●							
1.2. Objetivos estratégicos con enfoque en TI.	●	●				●	●	
1.3. Posicionamiento a través de plataformas digitales.								
1.4. Estrategias de fidelización de estudiantes con enfoque digital.	●	●						
1.5. Iniciativas digitales alineadas con estrategia corporativa.			●		●			
2. Cultura Digital								
2.1. Capacitación con enfoque en tecnologías digitales.	●			●			●	
2.2. Impulso a proyectos en temáticas digitales.	●			●			●	
2.3. Tolerancia a los cambios.				●				
2.4. Habilidad de aprendizaje continuo.				●			●	
2.5. Enfoque integral en la experiencia del estudiante (se relaciona con 4.3)	●	●	●	●	●	●	●	●
3. Organización y Estructura								
3.1. Tecnologías digitales presentes en procesos organizacionales		●						
3.2. Procesos administrativos digitalizados.		●						
3.3. Tecnologías digitales en flujos de trabajo.	●					●		
3.4. Estructura organizacional adaptable a lo digital.			●			●		
3.5. Toma de decisiones incorporando TI.		●	●					
4. Capacidades críticas y recursos claves								
4.1. Toma de decisiones guiadas por datos								
4.2, Enfoque TI en fidelización estudiante y marca universidad.					●			
4.3. Solución de problemas a estudiantes, con enfoque TI. (se relaciona con 2.5)	●	●	●		●	●	●	●
4.4. Tecnologías en optimización del back – office de la organización.								
4.5. Servicios accesibles en todo lugar y momento					●			
5. Valor del ciclo de vida del estudiante.								
5.1. Digitalización ciclo de vida del estudiante.	●				●			
5.2. Incorporación de TI para satisfacción y retención del estudiante.	●	●	●	●	●			
5.3. Acompañamiento académico y pedagógico con enfoque en TI.		●	●		●			●
5.4. Prácticas laborales y búsqueda de empleo con enfoque digital.					●			
5.5. Incorporación de TI para continuidad de estudios.		●			●			
6. Ecosistema (socios y aliados estratégicos que debiera tener una Universidad)								
6.1. Relaciones con empresas y corporaciones				●			●	
6.2. Relaciones con comunidades y grupos sociales							●	
6.3. Relaciones con Fundaciones/ONG.							●	
6.4. Relaciones con Universidades internacionales.							●	
6.5. Vínculos con la comunidad educativa y profesores de otras universidades.							●	
7. Enseñanza flexible y personalizada (pasa a ser un factor de la dimensión 4)								
7.1. Incorporación de TI en el ritmo de estudio alumno.	●		●	●			●	●
7.2. Modelo de enseñanza adecuado al lugar físico del alumno.								●
7.3. Utilización de datos predictivos para anticipar las necesidades del alumno.								
7.4. Sistema de asesoramiento individualizado								
7.5. Adecuación de enseñanza al perfil de cada estudiante.								●
8. Puntos de contacto con el estudiante								
8.1. Biblioteca digitalizada							●	
8.2. Plataforma digital para asuntos estudiantiles								●
8.3. Apoyo TI para fomentar grupos de trabajo							●	
8.4. Apoyo digital a la relación estudiante-director de carrera-secretaria.								
9. Redes sociales e investigación de perfiles								
9.1. Análisis de indicadores de posicionamiento								
9.2. Análisis de percepciones de estudiantes en RRSS.								
9.3. Identificación de puntos de mejora en los servicios digitales.								
9.4. Captación de estudiantes potenciales a través de RRSS.								
9.5. Fomento de aprendizaje colaborativo en RRSS.								
10. Procesos de transformación de la docencia para la educación superior								
10.1. Aplicación de TICs en el proceso de enseñanza aprendizaje.	●	●	●	●	●	●	●	●
10.2. Capacitación en estrategias pedagógicas digitales.	●		●		●			
10.3. Integración proyecto de vida alumno - estrategia de enseñanza.			●		●			
10.4. Incorporación de estrategias digitales de enseñanza en procura de la integración familiar					●			
10.5. Integración nivel socioeconómico del alumno con estrategias de enseñanza digitales.								
11. Inversión en TI / Pasa a llamarse gobernanza informática								
11.1. Inversión en plataformas tecnológicas de aprendizaje.	●				●		●	
11.2. Soporte técnico de calidad en procesos digitales.		●			●			
11.3. Automatización de servicios docentes dirigidos a sus estudiantes						●		
11.4. Inversión en plataformas tecnológicas administrativas	●		●	●	●			
11.5. Mejora de puntos de contacto con estudiantes a través de TICs.	●	●	●		●	●	●	

ANEXO V

Cuestionario M4 / Satisfacción estudiantil en un contexto de transformación digital universitaria

Gracias por acceder a este cuestionario destinado a conocer sus percepciones y expectativas respecto a la transformación digital de la Universidad Autónoma de Chile, y cómo esa transformación influirá en su satisfacción como estudiante.

La transformación digital es una de las principales respuestas de las instituciones educativas a los actuales retos tecnológicos y sociales, y debe ser entendida como un proceso de gestión que orienta la cultura, la estrategia, las metodologías y las capacidades de una organización a partir del uso de tecnologías digitales (Crespo y Pariente, 2018).

Este cuestionario es anónimo y consta de dos partes:

En la primera parte (DATOS GENERALES) Se le pedirá información general sobre su perfil (género, nivel académico que está cursando y disciplina a la que pertenece).

La segunda parte (IMPACTO DE LA TRANSFORMACIÓN DIGITAL) está integrada por seis bloques. En cada bloque encontrará un conjunto de ítems que podrá responder utilizando una escala del 1 al 10, donde 1 es el valor más negativo y 1o el valor más positivo, pudiendo elegir cualquier valor de esa escala.

Sus respuestas serán fundamentales para el buen desarrollo de esta investigación, por lo que de antemano agradecemos la sinceridad de sus respuestas y el tiempo que destinará a rellenar este cuestionario (aproximadamente 15 minutos).

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SECCIÓN 1: DATOS GENERALES

Por favor, seleccione la opción que mejor le defina

1.3 Género

- ○ Femenino
- ○ Masculino
- ○ Otro

1.4 Nivel académico

- ○ Estudiante Universitario (nivel pregrado)
- ○ Otro nivel académico

1.3 Área disciplinar a la que pertenece

- ○ Administración y Economía
- ○ Arquitectura, Construcción y Medio Ambiente
- ○ Ciencias de la Salud
- ○ Educación
- ○ Informática
- ○ Ingeniería
- ○ Otro

SEGUNDA PARTE: IMPACTO DE LA TRANSFORMACIÓN DIGITAL

A continuación, se muestran 6 bloques de indicadores relacionados con el **impacto de la transformación digital** de la Universidad Autónoma de Chile en sus estudiantes. En cada uno de esos bloques se muestra un conjunto de afirmaciones para que usted emita su opinión seleccionando un valor entre 1 y 10.

Por favor, lea detenidamente cada uno de los requerimientos del cuestionario y responda cada *ítem* de la manera más sincera posible. Sus respuestas serán tomadas en cuenta para asegurar que el proceso de transformación digital de la UA aporte grandes beneficios a la comunidad educativa.

Bloque 1: (Imagen de la Universidad)

Por favor, utilizando una escala del 1 al 10, donde el valor 1 significa *"En Total Desacuerdo"* y el valor 10 significa *"Totalmente de Acuerdo"*, pudiendo elegir cualquier número entre 1 y 10. **¿Qué tan de acuerdo o en desacuerdo se encuentra usted con cada una de las siguientes afirmaciones?**

(haga clic sobre el círculo que corresponda al valor de su escogencia)

1.1. Con el proceso de transformación digital, la Universidad Autónoma de Chile (UA) demuestra interés en atender mis requerimientos como estudiante, de forma oportuna y adecuada.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

1.2. Con el proceso de transformación digital, la UA demuestra un compromiso continuo con la innovación y la gestión tecnológica para mejorar los servicios educativos.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

1.3. La Universidad Autónoma de Chile, cuando sea tecnológicamente avanzada, será bien valorada por la comunidad y obtendrá un amplio reconocimiento social.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

1.4. Estudiar y graduarme en la UA me dará prestigio personal y profesional.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

1.5. El proceso de transformación digital de la UA influirá favorablemente en el ambiente social de la Universidad.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

Bloque 2: (Expectativas del estudiante)

Por favor, utilizando una escala del 1 al 10, donde el valor 1 significa *"En Total Desacuerdo"* y el valor 10 significa *"Totalmente de Acuerdo"*, pudiendo elegir cualquier número entre 1 y 10. **¿Qué tan de acuerdo o en desacuerdo se encuentra usted con cada una de las siguientes afirmaciones?**

(haga clic sobre el círculo que corresponda al valor de su escogencia)

2.1. Con la transformación digital de la Universidad podré acceder a mi historial académico y administrativo en el momento que lo desee.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

2.2. La transformación digital de la UA facilitará la realización de los procesos administrativos (por ejemplo: inscripciones, pago de aranceles, etc.)

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

2.3. Con la transformación digital de la Universidad tendré asesoramiento personalizado y el modelo de enseñanza estará adecuado a mi perfil académico y socioeconómico.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

2.4. Con la transformación digital de la UA podré integrarme fácilmente a grupos de trabajo y redes de investigación.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

2.5. Con la transformación digital de la Universidad podré acceder, cuando lo desee, a una biblioteca digitalizada y a otros recursos de aprendizaje *online.*

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

2.6. La transformación digital de la UA permitirá que la comunicación con los docentes y el personal que labora en el ámbito académico (directores de programa, coordinadores, decanos, secretarias, etc.) sea oportuna y eficaz.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

2.7. Con la transformación digital de la UA me será más fácil realizar mis prácticas laborales, encontrar empleo y alcanzar mis metas profesionales.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

Bloque 3: (Calidad esperada)

Por favor, utilizando una escala del 1 al 10, donde el valor 1 significa *"En Total Desacuerdo"* y el valor 10 significa *"Totalmente de Acuerdo"*, pudiendo elegir cualquier número entre 1 y 10. **¿Qué tan de acuerdo o en desacuerdo se encuentra usted con cada una de las siguientes afirmaciones?**

(haga clic sobre el círculo que corresponda al valor de su escogencia)

3.1. Cuando la Universidad Autónoma de Chile incorpore tecnologías digitales en los procesos de enseñanza-aprendizaje, mi rendimiento académico será mayor que en la actualidad, y también será más fácil alcanzar mis metas educativas.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

3.2. Con la transformación digital de la Universidad, no tendré que limitarme al horario de trabajo de la facultad para solicitar las calificaciones o mi historial académico.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

3.3. Con la transformación digital de la UA, las inscripciones, el pago de aranceles y otros procesos administrativos serán más rápidos, eficientes y confiables que los actuales.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

3.4. La posibilidad de pertenecer a un grupo de trabajo será significativamente mayor si la UA establece vínculos con otras universidades y grupos de investigación mediante la utilización de tecnologías digitales.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

3.5. Con la transformación tecnológica de la UA, la disponibilidad y el acceso a recursos digitales de aprendizaje, incluyendo los servicios de biblioteca, serán significativamente mejores que en la actualidad.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

3.6. Mi comunicación con el personal docente y administrativo de la facultad mejorará de forma sustancial gracias a la transformación digital de la UA.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

3.7. La posibilidad de encontrar empleo y de lograr mis metas profesionales será mayor si la Universidad lleva a cabo un proceso de transformación digital.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

Bloque 4: (Valor esperado)

Por favor, utilizando una escala del 1 al 10, donde el valor 1 significa *"En Total Desacuerdo"* y el valor 10 significa *"Totalmente de Acuerdo"*, pudiendo elegir cualquier número entre 1 y 10. **¿Qué tan de acuerdo o en desacuerdo se encuentra usted con cada una de las siguientes afirmaciones?**

(haga clic sobre el círculo que corresponda al valor de su escogencia)

4.1. La relación entre el precio que deberé pagar y la calidad de la educación que voy a recibir luego de la transformación digital de la Universidad, será mejor que la relación actual: *"precio/calidad educativa"*.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

4.2. La relación entre el precio que deberé pagar y la calidad de los servicios que voy a recibir luego de la transformación digital de la Universidad (biblioteca digitalizada, sala de computación, comedores, atención al estudiante, programas de intercambio, etc.) será mejor que la relación actual: *"precio/calidad de servicios"*.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

4.3. La relación entre el precio que deberé pagar luego de la transformación digital de la UA y el prestigio profesional que obtendré por estudiar y graduarme en esta Universidad, será mejor que la actual relación: *"precio/valor"*.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

Bloque 5: (Satisfacción)

Por favor, utilizando una escala del 1 al 10, pudiendo elegir cualquier número entre esos valores, **indique su valoración sobre cada uno de los siguientes *ítems*** (los significados de la escala se muestran en cada *ítem*),

(haga clic sobre el círculo que corresponda al valor de su escogencia)

5.1. Imagine a la Universidad Autónoma de Chile después de llevar a cabo la transformación digital ¿Qué tan satisfecho o insatisfecho piensas que estaría con los procesos administrativos de la universidad?

	1	2	3	4	5	6	7	8	9	10	
Totalmente Insatisfecho	○	○	○	○	○	○	○	○	○	○	Totalmente Satisfecho

5.2. Después de que la Universidad Autónoma se transforme digitalmente ¿Qué tan satisfecho estaría con el proceso de enseñanza-aprendizaje, incluyendo el apoyo personalizado que recibirá?

	1	2	3	4	5	6	7	8	9	10	
Totalmente Insatisfecho	○	○	○	○	○	○	○	○	○	○	Totalmente Satisfecho

5.3. Después de que la Universidad Autónoma se transforme digitalmente ¿Qué tan satisfecho o insatisfecho se sentiría con el acceso a la información y los servicios que ofrecen los distintos departamentos de la universidad?

	1	2	3	4	5	6	7	8	9	10	
Totalmente Insatisfecho	○	○	○	○	○	○	○	○	○	○	Totalmente Satisfecho

5.4. Si la Universidad Autónoma estuviese transformada tecnológicamente ¿Qué tan satisfecho o insatisfecho se sentiría con la comunicación con los docentes y el personal que labora en el ámbito académico?

	1	2	3	4	5	6	7	8	9	10	
Totalmente Insatisfecho	○	○	○	○	○	○	○	○	○	○	Totalmente Satisfecho

5.5. ¿Hasta qué punto la transformación digital de la Universidad Autónoma le permitirá satisfacer sus expectativas como estudiante y futuro profesional?

	1	2	3	4	5	6	7	8	9	10	
No serán satisfechas	○	○	○	○	○	○	○	○	○	○	Serán totalmente satisfechas

Bloque 6: (Lealtad)

Por favor, utilizando una escala del 1 al 10, donde el valor 1 significa *"En Total Desacuerdo"* y el valor 10 significa *"Totalmente de Acuerdo"*, pudiendo elegir cualquier número entre 1 y 10. **¿Qué tan de acuerdo o en desacuerdo se encuentra usted con cada una de las siguientes afirmaciones?**

(haga clic sobre el círculo que corresponda al valor de su escogencia)

6.1. De ser posible, volvería a elegir a la Universidad Autónoma de Chile para cursar mis estudios.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

6.2. Si tuviera la oportunidad de estudiar en otro sitio dejaría esta Universidad, aun cuando perciba que la transformación digital pueda ser beneficiosa para mí.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

6.3. La transformación tecnológica de la Universidad Autónoma de Chile aumentaría mi preferencia hacia ella para cursar mis estudios.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

6.4. Si me piden la opinión, recomendaré esta Universidad a otras personas.

	1	2	3	4	5	6	7	8	9	10	
En total Desacuerdo	○	○	○	○	○	○	○	○	○	○	Totalmente de Acuerdo

ANEXO VI

Cuestionario M4 / Cuestionario para validación de contenido (juicio de expertos)

Gracias por acceder a este instrumento.

Usted ha sido seleccionado como experto para validar un cuestionario destinado a conocer de qué manera los estudiantes de la Universidad Autónoma de Chile perciben el impacto de la transformación digital de esta Universidad en su nivel de satisfacción. La investigación forma parte de un estudio más amplio que se está desarrollando a nivel doctoral.

Para efectos de esta investigación, la transformación digital debe ser entendida como el proceso de gestión que orienta la cultura, la estrategia, las metodologías y las capacidades de una organización a partir del uso de las tecnologías digitales (Crespo y Pariente, 2018), siendo una de las principales respuestas de las instituciones educativas a los actuales retos tecnológicos y sociales.

Este cuestionario está dividido en 6 bloques que corresponden al Modelo de Satisfacción del Estudiante, propuesto por Turkyilmaz, Temizer y Oztekin (2016).

En cada bloque se presenta un conjunto de ítems que los estudiantes podrán responder utilizando una escala del 1 a 10, donde 1 es el valor más negativo y 10 el valor más positivo, pudiendo elegir cualquier valor de esa escala.

En esta oportunidad le pedimos su opinión sobre la claridad de la redacción y la facilidad de comprensión de cada ítem. Si lo desea, podrá sugerir cualquier cambio que considere de utilidad para los fines planteados.

Sus apreciaciones serán fundamentales para el buen desarrollo de esta investigación, por lo que de antemano agradecemos la sinceridad de sus opiniones y el tiempo destinado para rellenar el cuestionario.

Para comenzar, por favor haga clic en el botón **"SIGUIENTE"**

Bloque 1: Imagen de la Universidad

ÍTEMS DEL BLOQUE 1	NO SE ENTIENDE EL ENUNCIADO	SE ENTIENDE CON DIFICULTADES	FÁCILMENTE COMPRENSIBLE
1a. Con el proceso de transformación digital, la Universidad Autónoma de Chile (UA) demuestra interés en atender mis requerimientos como estudiante, de forma oportuna y adecuada.			
1b. Con el proceso de transformación digital, la UA demuestra un compromiso continuo con la innovación y la gestión tecnológica para mejorar los servicios educativos			
1c. La Universidad Autónoma de Chile, cuando sea tecnológicamente avanzada, será bien valorada por la comunidad y obtendrá un amplio reconocimiento social			
1d. Estudiar y graduarme en la UA me dará prestigio personal y profesional.			
1e. El proceso de transformación digital de la UA influirá favorablemente en el ambiente social de la Universidad.			

Comentarios / Recomendaciones
(solo si lo considera necesario)

Bloque 2: Expectativas del estudiante

ÍTEMS DEL BLOQUE 2	NO SE ENTIENDE EL ENUNCIADO	SE ENTIENDE CON DIFICULTADES	FÁCILMENTE COMPRENSIBLE
2a. Con la transformación digital de la Universidad podré acceder a mi historial académico y administrativo en el momento que lo desee.			
2b. La transformación digital de la Universidad facilitará la realización de los procesos administrativos (por ejemplo: inscripciones, pago de aranceles, etc.).			
2c. Con la transformación digital de la Universidad tendré asesoramiento personalizado y el modelo de enseñanza estará adecuado a mi perfil académico y socioeconómico.			
2d. Con la transformación digital de la Universidad podré integrarme fácilmente a grupos de trabajo y redes de investigación.			
2e. Con la transformación digital de la Universidad podré acceder, cuando lo desee, a una biblioteca digitalizada y a otros recursos de aprendizaje online			
2f. La transformación digital de la Universidad permitirá que la comunicación con los docentes y el personal que labora en el ámbito académico (directores de programa, coordinadores, decanos, secretarias, etc.) sea oportuna y eficaz.			
2g. Con la transformación digital de la Universidad me será más fácil realizar mis prácticas laborales, encontrar empleo y alcanzar mis metas profesionales.			

Comentarios / Recomendaciones
(solo si lo considera necesario)

Bloque 3: Calidad esperada

ÍTEMS DEL BLOQUE 3	NO SE ENTIENDE EL ENUNCIADO	SE ENTIENDE CON DIFICULTADES	FÁCILMENTE COMPRENSIBLE
3ª. Cuando la Universidad Autónoma de Chile incorpore tecnologías digitales en los procesos de enseñanza-aprendizaje, mi rendimiento académico será mayor que en la actualidad, y también será más fácil alcanzar mis metas educativas.			
3b. Con la transformación digital de la Universidad, no tendré que limitarme al horario de trabajo de la facultad para solicitar las calificaciones o mi historial académico.			
3c. Con la transformación digital de la Universidad, las inscripciones, el pago de aranceles y otros procesos administrativos serán más rápidos, eficientes y confiables que los actuales.			
3d. La posibilidad de pertenecer a un grupo de trabajo será significativamente mayor si la Universidad establece vínculos con otras universidades y grupos de investigación mediante la utilización de tecnologías digitales.			
3e. Con la transformación tecnológica de la Universidad, la disponibilidad y el acceso a recursos digitales de aprendizaje, incluyendo los servicios de biblioteca, serán significativamente mejores que en la actualidad.			
3f. Mi comunicación con el personal docente y administrativo de la facultad mejorará de forma sustancial gracias a la transformación digital de la Universidad.			
3g. La posibilidad de encontrar empleo y de lograr mis metas profesionales será mayor si la Universidad lleva a cabo un proceso de transformación digital.			

Comentarios / Recomendaciones
(solo si lo considera necesario)

Bloque 4: Valor esperado

ÍTEMS DEL BLOQUE 4	NO SE ENTIENDE EL ENUNCIADO	SE ENTIENDE CON DIFICULTADES	FÁCILMENTE COMPRENSIBLE
4a. La relación entre el precio que deberé pagar y la calidad de la educación que voy a recibir luego de la transformación digital de la Universidad, será mejor que la relación actual: "precio/calidad educativa".			
4b. La relación entre el precio que deberé pagar y la calidad de los servicios que voy a recibir luego de la transformación digital (biblioteca digitalizada, sala de computación, comedores, atención al estudiante, programas de intercambio, etc.) será mejor que la relación actual: "precio/calidad de servicios".			
4c. La relación entre el precio que deberé pagar luego de la transformación digital y el prestigio profesional que obtendré por estudiar y graduarme en esta Universidad, será mejor que la actual relación: "precio/valor".			

Comentarios / Recomendaciones
(solo si lo considera necesario)

Bloque 5: Satisfacción

ÍTEMS DEL BLOQUE 5	NO SE ENTIENDE EL ENUNCIADO	SE ENTIENDE CON DIFICULTADES	FÁCILMENTE COMPRENSIBLE
5a. Imagine a la Universidad Autónoma de Chile (UA) después de llevar a cabo la transformación digital ¿Qué tan satisfecho o insatisfecho piensa que estaría con los procesos administrativos de la universidad?			
5b. Después que la UA se transforme digitalmente ¿Qué tan satisfecho estaría con el proceso de enseñanza-aprendizaje, incluyendo el apoyo personalizado que recibirá?			
5c. En la UA digitalizada ¿Qué tan satisfecho o insatisfecho se sentiría con el acceso a la información y los servicios que ofrecen los distintos departamentos de la universidad?			
5d. Si la UA estuviese transformada tecnológicamente ¿Qué tan satisfecho o insatisfecho se sentiría con la comunicación con los docentes y el personal que labora en el ámbito académico?			
5e. ¿Hasta qué punto la transformación digital de la Universidad le permitirá satisfacer sus expectativas como estudiante y futuro profesional?			

Comentarios / Recomendaciones
(solo si lo considera necesario)

Bloque 6: Lealtad

ÍTEMS DEL BLOQUE 6	NO SE ENTIENDE EL ENUNCIADO	SE ENTIENDE CON DIFICULTADES	FÁCILMENTE COMPRENSIBLE
6a. De ser posible, volvería a elegir a la Universidad Autónoma de Chile para cursar mis estudios.			
6b. Si tuviera la oportunidad de estudiar en otro sitio dejaría esta Universidad, aun cuando perciba que la transformación digital pueda ser beneficiosa para mí.			
6c. La transformación tecnológica de la Universidad aumentaría mi preferencia hacia ella para cursar mis estudios.			
6d. Si me piden la opinión, recomendaré esta Universidad a otras personas.			

Comentarios / Recomendaciones
(solo si lo considera necesario)

ANEXO VII

Cuestionario M4 / Datos del proceso de validación de contenido por juicio de expertos

Validación de contenido (método Lawshe)

	1a	1b	1c	1d	1e	2a	2b	2c	2d	2e	2f	2g	3a	3b	3c	3d	3e	3f	3g	4a	4b	4c	5a	5b	5c	5d	5e	6a	6b	6c	6d	
Ev. 1	3	3	3	3	2	3	3	3	3	3	3	2	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	2	
Ev. 2	3	3	3	2	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	
Ev. 3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Ev. 4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Ev. 5	3	3	3	3	3	3	3	3	3	3	3	2	3	2	2	3	3	3	3	3	3	3	3	2	2	3	3	3	3	3	3	
Ev. 6	3	3	3	3	2	2	2	1	2	1	2	2	2	3	3	2	3	3	2	2	2	2	2	1	2	2	3	3	3	3	3	
Ev. 7	3	2	3	3	3	3	3	3	3	3	2	3	2	3	3	3	3	2	3	1	2	2	3	2	3	2	3	3	1	3	3	
Ev. 8	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Ev. 9	3	3	2	3	2	3	3	2	2	3	2	3	2	3	3	2	3	3	3	3	2	2	2	2	3	3	2	3	3	2	3	
Ev. 10	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
(n3)	10	9	9	9	7	9	9	6	8	9	7	7	6	9	9	8	10	8	9	8	7	7	8	5	8	8	9	10	9	9	9	**Media CVR**
CVR	1,00	0,80	0,80	0,80	0,40	0,80	0,80	0,20	0,60	0,80	0,40	0,40	0,20	0,80	0,80	0,60	1,00	0,60	0,80	0,60	0,40	0,40	0,60	0,00	0,60	0,60	0,80	1,00	0,80	0,80	0,80	**0,645**
																														CVR´	**0,823**	
																														Mínimo CVR' (10 ev.) = 0,60		

ANEXO VIII

Justificante de aceptación del artículo titulado: Digital transformation model for universities: a preliminary proposal (artículo 2)

De: Conscientia Beam Journals <articlestatus@conscientiabeam.com>
Enviado el: lunes, 4 de septiembre de 2023 2:04
Para: Javier Manuel Muñoz Acuña <javier.munoz@uautonoma.cl>
Asunto: Editorial Decision: Article ID- IJEP /2644/23

Dear Javier Manuel Muñoz Acuña
Congratulations!

International Journal of Education and Practice
E-2310-3868/P-2311-6897
URL: http://www.conscientiabeam.com/journal/61

We are happy to let you know that your article **"Digital Transformation Model for Universities: A Preliminary Proposal**. According to the journal's current policy, after acceptance, the author will need to pay (USD 1000 as an article processing fee). Your article was evaluated in a blind review process by two referees in addition to the input from the editor. Your article will available online within 50 to 60 working days after receiving the publication fee.

Please find in attachment the account information in order to pay the article processing fee total USD 1000.

Please remember to quote the manuscript number, **IJEP/2644/23,** whenever inquiring about your manuscript.

Please acknowledge the receiving of the acceptance letter and reply us then we will start the process of your paper formatting in the journal's style. Before online publication, we will send you final formatted article for proofreading.

If you require further information, please do not hesitate to write me.

I look forward to hearing from you soon.

Thanks and best regards,

Sanele Phillip
Editorial Office
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(Please always quote the article title and paper no. in any communication to us)

ANEXO IX

Justificante de aceptación del artículo titulado: Validation of the digital transformation model of the Autonomus University of Chile (artículo 3)

International Association of Online Engineering IAOE.

IAOE - Kirchengasse 10/200 - A-1070 Wien - Austria

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2023-07-31

Dear Javier Manuel Muñoz Acuña,

it is a pleasure for us to confirm that your paper *Validation of the digital transformation model of the Autonomous University of Chile* (author(s): Javier Manuel Muñoz Acuña, Felipe Hernández-Perlines, Manuel Alejandro Ibarra Cisneros) has undergone peer review and has been accepted for publication in the International Journal of Emerging Technologies in Learning (iJET, eISSN: 1863-0383).

iJET is indexed in EI Compendex, Scopus, dblp, LearnTechLib, and EBSCO.

Thank you for working with us!

Sebastian Schreiter
Associate Editor