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Digital transformation in universities: models, frameworks and road map

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Abstract: Digital Transformation seeks to improve the processes of an organisation by integrating digital technology in all its areas, this is inevitable due to technological evolution that generates new demands, new habits and greater demands on customers and users, therefore Digital Transformation is important. In organisations to maintain competitiveness. In this context, universities are no strangers to this reality, but they find serious problems in their execution, it is not clear how to deal with an implementation of this type. The work seeks to identify tools that can be used in the implementation of Digital Transformation in universities, for this a systematic review of literature is carried out with a method based on three stages, 23 models, 13 frameworks and 8 roadmaps are identified. The elements found are analysed, obtaining eight main components with their relationships and dependencies, which can be used to generate more optimal models for universities.

Keywords: digital transformation; primary components; models; framework; roadmap; universities; implementation processes.

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Biographical notes: Marco A. Coral Ygnacio is an Associate Professor at the Universidad Nacional Mayor de San Marcos, with doctoral studies in Systems Engineering, researches digital transformation processes in universities and works on projects aimed at zero paper (paperless). He has been responsible for the transformation of administrative processes at UNMSM.

1 Introduction

Digital transformation (DT) seeks to optimise the processes of an organisation, improve its competitiveness and offer new and better experiences to its end customers, by activating significant changes in its structure using information, computing, communication and connectivity technologies (García-Peñalvo, 2021; Lucija et al., 2019; Vial, 2019, 2021; Vukšić et al., 2018). The DT is a process that allows the reinvention, reconstitution and reform of the organisation from the use of digital technologies to

generate, store and process large volumes of data. In addition, it can be understood as the result of the evolution of technologies within the framework of digital innovation (Lasi et al., 2014), which produces a convergence of business processes and technologies, since it involves the modification or adaptation of the business model from the organisational point of view (Kotarba, 2018), which in turn responds to the dynamic rhythm of technology that triggers changes in social behaviour and in the consumption of products and services by the end customer.

DT involves three aspects (Coral and Bernuy, 2021; Kaminskyi et al., 2018; Sandhu, 2018): technological, organisational and social. In the technological aspect, greater emphasis is given to the use of social networks, mobile devices, trend analysis, predictions, cyber-physical devices, systems based on artificial intelligence, etc. (Gopal et al., 2019; Nedelcu et al., 2018). In the organisational aspect, new strategies are generated in the business, changes in the processes and new business models are created (Ahmad et al., 2020), and in the social aspect, it seeks to improve the customer experience in receiving and consuming products and services (Reis et al., 2018).

In the context of universities, it is required that they modernise their processes, strategically align themselves with the evolution of technologies and the market in order to remain competitive, in this scenario, the administrative and academic processes become important since they are the basis for the generation of the different services for the university community, Therefore, it is necessary to change the procedures and work culture and integrate digital technology in the different dependencies and operational areas, this assumes a DT process (Benavides et al., 2020; Fleacă, 2017). DT in universities is generally based on digitisation processes, having many difficulties due to the business model that generally does not consider technological processes, some models and frameworks consider the vision and business model of the university as base components for DT in universities (Crue-TIC, 2017). Studies on DT issues indicate that the greatest concern is the lack of guidelines to direct the process (Benavides et al., 2020), followed by digitisation processes (Crue-TIC, 2017; Martín, 2018) and the creation of an area that generates and directs the process in the organisation (Faria and Nóvoa, 2017). The DT in the universities can be carried out from a model, for this reason several authors propose models and frameworks based on the experiences acquired by the companies and institutions that have developed these processes. Most of the proposed models are based on pillars (Crue-TIC, 2017; Arango et al., 2019; Perez Gama et al., 2018; Loureiro et al., 2021; Fernández Martínez et al., 2019; Westerman et al., 2011) that must be digitally transformed, the pillars are described from blocks which are elements that must be built to achieve the objectives of the DT, the specialised literature describes these blocks as processes where digital technologies are vital for their creation (Vial, 2021; Soto Setzke et al., 2021), these must generate value in order to maintain competitiveness and generate positive impacts for the organisation, person and society, studies on DT models that have been implemented in universities are scarce and have different approaches (Arango et al., 2019). The frameworks reflect the intention, the criteria and the practices to be taken into account in a DT process, there are frameworks that focus on the teaching-learning process (Schneckenberg, 2009; Dörner and Rundel, 2021), and others oriented to the operative processes which are the support for the emission of the educational service (Demartini et al., 2020), at a first level, DT focuses on the operational or administrative processes of universities, but there are few studies that deal with these issues. The roadmaps determine the action plan and detail the activities to be carried out to achieve the objectives defined in the DT (Zaoui and Souissi,

2020; Schallmo et al., 2017), most of the reviewed studies focus on business objectives, with few studies associated with the educational objectives pursued by a university.

The present study carries out a systematic literature review of models, frameworks and roadmaps for universities, with the purpose of generating implementation proposals in DT processes in universities, for this we follow the following stages: planning of the review, development of the review and results of the review. The findings can serve to create a valid guide to start DT in universities.

This work is organised into seven sections: Section 2 provides background on DT in universities and the aspects covered by DT, research methodology, planning, development and search results are shown in Section 3, the analysis and answers to the research questions are found in Section 4, in point 5 the components identified in the models and frameworks studied are discussed, followed by the conclusions in Section 6 and the references at the end.

2 Background

2.1 Digital transformation

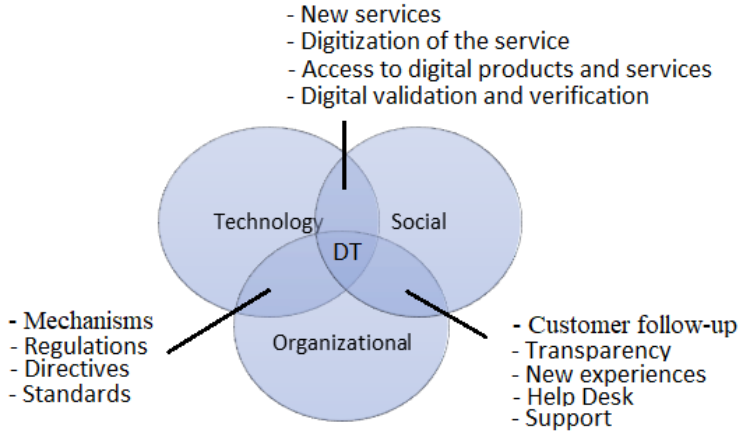
Digital Transformation is a process of change based on digital technologies, the concept includes organisational changes and the use of digital technologies but this is relative since there is no exact formula on the amount or type of digital technology to use, nor the exact form or methodology for changes in the organisation. We can identify the main components or parts from the concept of Digital Transformation: Technological, Social and Organisational, which must converge and interact with each other to generate Digital Transformation in an organisation, it is not possible to have processes that do not contemplate any of these components or aspects and that are not interrelated with each other (Reis et al., 2018). Figure 1 shows the components and the corresponding iterations between them, we can observe the relationship between the technological and organisational aspects from the mechanisms (regulations, procedures, etc.) generated in order to adapt, use and guarantee the use of the technologies in the processes of the organisation, in the same way between the technological and social aspect through services based on digital technologies (new services, adaptation of technological services, etc.), finally the relationships between the organisational and social aspect are shown which is based on the adequacy of the service to guarantee its quality, based on the criteria identified for the service applicant (short times, transparency and consultations, real-time monitoring of its operations, etc.).

2.2 Digital transformation in universities

The COVID-19 Pandemic has forced a rapid redesign of business processes, which have migrated to remote work supported by various technological means. In this context, the organisations that have the most problems in evolving and transforming are educational institutions where the processes and work methods are established in a deeply rooted way and it is difficult to change the form and perspective of work, bureaucracy, excessive control and mistrust prevent the correct development of the organisation, operational decisions must go through multiple filters and agreements between the parties that make it up, these processes generate bureaucracy, slowness and remove added value from the

process. A sample of these institutions are the Universities which work on an educational model that does not consider modern technological processes (Coccoli et al., 2014), policies, processes and administrative management have not been designed to support these processes (Selwyn, 2007), which hinders the adoption of technology and the redefinition of processes based on the user, the government adjusts to multiple regulations and in many cases to multiple interpretations, the personnel responsible for each area is constantly removed depending on how the organisation is managed, this generates that the administrative processes and services offered are deficient, slow and subject to multiple complaints by end users.

Figure 1 Convergence of the components of the digital transformation (see online version for colours)



Source: Adapted from Coral and Bernuy (2021)

Various studies agree that one of the most important problems to take into account in universities is the management model used (Fernández Jeri, 2015), Since it directly affects the achievement of institutional objectives and educational quality, the management model defines the mechanisms and regulations to be used in the different administrative processes of the universities, These processes refer to the activities that are part of the core business of the institution which is formally defined, there are specific functions and roles for its execution (Llamosa-Villalba et al., 2010), in this context, administrative processes are key to maintaining business in universities, their correct management and execution being important in order to meet institutional objectives, the use of technology in this aspect is vital to maintain competitiveness, taking into account that organisations are constantly changing and professionals must change, adapt and obtain digital skills, technology evolves at a faster rate than organisations or companies o the skills and competencies of most professionals (Cascio and Montealegre, 2016), Therefore, a crisis of digital skills could be generated in the various operational areas of the institutions (Fleacă, 2017; Internetsociety.org, 2017; Bond et al., 2018). This reality shows that Universities may not have the capacity to generate Digital Transformation processes, the intentions to generate these processes may be affected by their own practices, rigid structures and bureaucratic processes (Rodríguez-Abitia et al., 2021).

2.3 Aspects of implementation of the digital transformation

The Implementation of the Digital Transformation is complex since there are multiple initiatives and diverse studies on the subject, from the review carried out we can mention three elements as a fundamental basis to face a Digital Transformation process:

1 The model to be used, defined based on the strategic objectives of the University where people, processes and the business model must be considered, together with digital technologies.

2 The framework defines the conceptualisation of the process, the practices and criteria to be followed based on the problem to be solved (Westerman et al., 2011), we must consider that each Digital Transformation process is developed from its own context and situational state, therefore, despite having a model, the dimensions and approaches are different.

3 The Roadmap, determines the operational form and the strategy to follow in the process (Zaoui and Souissi, 2020), allows planning, defining deliverables and achievements.

The implementation of the Digital Transformation is governed by the model on which it is structured, there are various model proposals but all agree on three fundamental elements, components or pillars, which are digitally transformed using digital technologies: customer experience, operational processes and business model (Westerman et al., 2011), These pillars are described from blocks which are elements that must be built to achieve the objectives of Digital Transformation. The specialised literature describes these blocks as processes where digital technologies are vital for their creation (Vial, 2019, 2021), these must generate value in order to maintain competitiveness and generate positive impacts for organisations, people and society. University-oriented models emphasise the use of digitisation as support for the proposed components: processes, contact points, services and products, etc. (Crue-TIC, 2017), Others specifically indicate the implementation processes of the model using technologies (Forero et al., 2020), the other models base their development on digital technology as the main element for their achievement (Ifenthaler and Egloffstein, 2020; Sehlin et al., 2019).

The frameworks or reference frameworks are used to define, plan and organise the digital transformation processes in an organisation depending on the approach and the problem to be addressed. The literature shows multiple proposals based on the standardisation of concepts, practices and criteria in order to successfully face these processes (Demartini et al., 2020; Jin et al., 2020; Butt, 2020; Nylén and Holmström, 2015; Verina and Titko, 2019). The revised frameworks emphasise the use of digital technologies for their achievement (Westerman et al., 2011; Bican and Brem, 2020; van Tonder et al., 2020), In this sense, the implementation, development, acquisition or adoption of technology is part of the strategic work of the organisation arising from a need or problem, which entails the search for solutions based on existing technological innovations (Mirvis et al., 1991; Damanpour and Schneider, 2006), having as a starting point the digital capacity of the organisation.

In this context, the use of Roadmaps as a strategy to implement Digital Transformation becomes vital (Westerman et al., 2011; Fitzgerald et al., 2013), it is necessary to have mapped all the activities or steps to be developed in reasonable time

frames, the roadmaps represent the development plan to be used in a Digital Transformation strategy with the aim of optimally achieving the proposed objectives (Schallmo et al., 2017). The roadmaps mainly detail the process of digital implementation and the development of information systems (Benavides et al., 2020; Faria and Nóvoa, 2017; Schallmo et al., 2017) which is equivalent to digitisation processes and digitalisation (Parviainen et al., 2017), while the roadmaps aimed at universities involve in their processes the use of technologies based on the digital capacities of the institution (Fernández Martínez et al., 2019).

3 Methodology

A systematic review of the literature is carried out taking into account the stages presented by various authors in relation to Information Technology (Kitchenham and Charters, 2007; Oñate-Andino and Mauricio, 2019; Morakanyane et al., 2017), determining for it three phases as follows:

- *Review planning*: In this phase, the research questions are developed and the review protocol is defined.
- *Development of the review*: In this phase, the primary studies are selected according to the selection and exclusion criteria.
- *Results of the review*: In this phase, the statistics and the analysis performed for the studies that were previously selected are presented. The details of the analysis are explained in the following sections.

3.1 Review planning

To achieve the purpose of the research, the following research questions are proposed:

Q1. ¿What Digital Transformation Models can be used in universities?

Q2. ¿What Digital Transformation Framework can be used in universities?

Q3. ¿What Digital Transformation Roadmap can be used in universities?

Search sources come from the Database SCOPUS and Web of Science, for the investigation we use the following search string: ("digital transformation" OR digitalisation) AND (model* OR framework* OR roadmap) AND (university OR 'higher education' OR college) AND (implementation OR practiques OR strateg* OR plan* OR desig*), the search was carried out in Scopus in the title, abstract and keywords and in Web of Science from the topics.

3.2 Development the review

The criteria established for the search and selection of papers (Inclusion and exclusion) are shown in Table 1.

Table 1 Inclusion and exclusion criteria

	Criterion	*Reasons*
Inclusion	Research focus	Studies that identify models, framework or roadmap related to Digital Transformation processes in universities
	Quantitative empirical studies	These papers are included because they provide existing empirical evidence, which is the main interest of this review
	Publication type	Items in final state
	Language	Only studies in English are considered
	Period	2015–2021
	Area	Computer Science
Exclusion	Publication type	Books, book chapters, conference proceedings and dissertations
	Unit of Analysis	Studies that are not related to Digital Transformation implementations
	Research focus	Studies that do not show research methodology, numerical tests (descriptive statistics) and analysis or discussion
	Area	Studies that do not belong to the area of Computer Science

As a first step, the search for references is carried out according to the chain established in the databases: Scopus and Web of Science, the search was carried out on 10 December, 2021, omitting books, book chapters and conference proceedings, scientific papers in specialised journals were considered for being considered valid and quality knowledge due to their peer review processes (Ardito et al., 2015; Datta and Jones, 2018). The search procedure considered the publications available from the year 2015, were found 12,640 potential studies in SCOPUS and in Web of Science 717. The papers were filtered based on the inclusion and exclusion criteria in Table 1, remaining in SCOPUS 562 publications and in Web of Science 98, 50 duplicate works are found in the two databases, which give a total of 610 papers included, then they were filtered by the title, the keywords and the abstract considering only those that have to do with the subject of study, leaving 62 papers, a more detailed analysis of the papers is carried out considering the full text check, the introduction and conclusions are verified and finally, the complete content of the paper is read in order to determine if these studies identify models, framework or roadmap that can be used in Digital Transformation processes for universities, 13 papers are eliminated for not meeting the requirements of the topic, leaving 49 for the respective analysis. The detail of the process is shown in the Figure 2.

3.3 Review results

The result of the paper selection process yielded 12,640 studies of which 49 were selected, the number of papers represents the diversity of studies on the subject and the associations with other subjects contributions were chosen and analysed to answer the research questions. Table 2 shows the number of studies selected after applying the process flow of Figure 2.

Figure 2 Flow of the process for the selection of papers (see online version for colours)

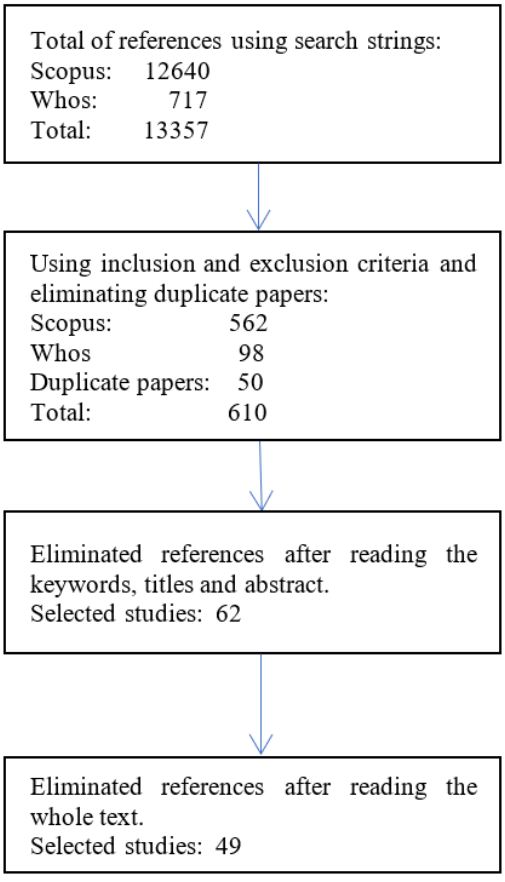


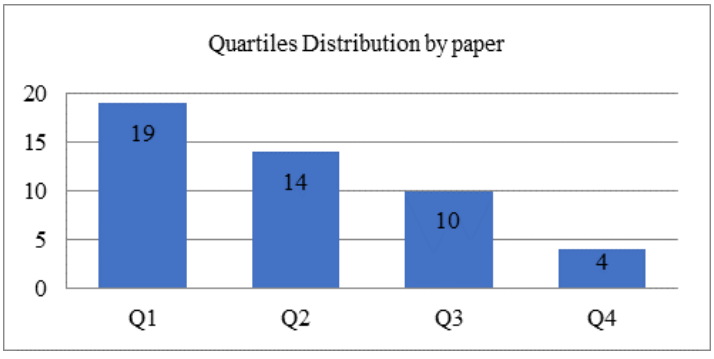
Table 2 Selected studies

Source	*Potentially eligible studies*	*Selected studies*
SCOPUS	12,640	47
Web of Science	717	17
Total	13,308*	49*

*There are studies that are repeated in both databases.

After selecting the papers, the journals that published the selected studies were analysed, For this, the SCImago Journal Rank indicator was used to obtain the Quartile where each Journal is located, one by one is verified in order to identify the scientific quality of the selected publications, the frequencies are calculated and the distribution by quartiles is generated, having 19 journals in Quartile 1, 14 in Quartile 2, 10 in Quartile 3 and 4 in Quartile 4, in addition there are 2 journals that were discontinued in 2020, therefore there is no detail of the indicator. The detail of the quartiles is shown in Figure 3.

Figure 3 Distribution of quartiles by papers (see online version for colours)



After selecting the papers, the trends of the publications per year were identified, the works from 2015 to 2021 were considered as shown in Figure 4, it is observed that in 2020 and 2021 the trend increases considerably with respect to previous years.

This can be explained with the pandemic and advances in digital technology, a greater interest in the subject is shown. The study is considered timely since the number of works related to implementations associated with Digital Transformation in Universities has recently increased.

Figure 4 Publications per year (see online version for colours)

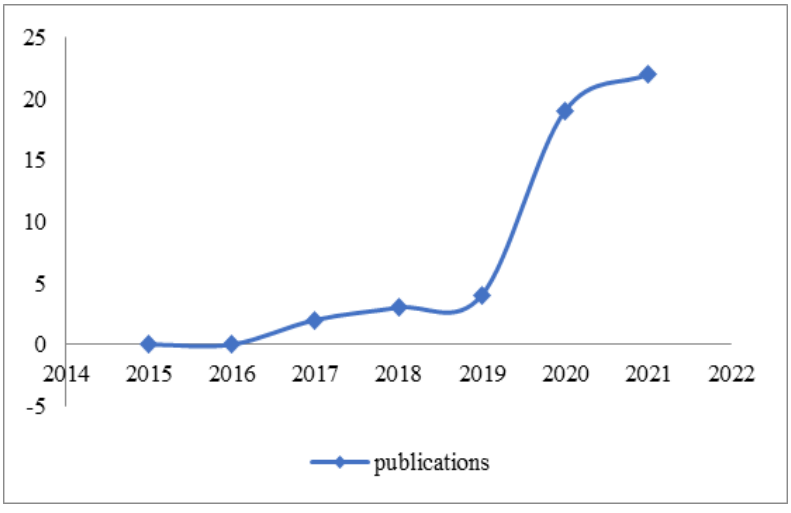


Table 3 shows the 10 most cited papers, it is observed that the first has 122 citations and was published in 2019, the second with 88 citations also published in 2019 and the third with 50 in 2018, this represents the growing interest in the subject of study, topics such as digitisation, strategies, challenges and agility are mentioned, it is shown that the largest number of citations are from works published since 2017, which supports the interest in recent years in the subject.

Table 3 Most cited papers. Top 10

Title	*Year of publication*	*Citations*
Digitalisation and its influence on business MODEL innovation	2019	122
Digital transformation strategy making in pre-digital organisations: The case of a financial services provider	2019	88
Challenges for digital transformation–towards a conceptual decision support guide for managers	2018	50
Agile digital transformation of System-of-Systems architecture MODELs using Zachman framework	2017	37
Architecture Board Practices in Adaptive Enterprise Architecture with Digital Platform: A Case of Global Healthcare Enterprise	2018	28
An adaptive enterprise architecture framework and implementation: Towards global enterprises in the era of cloud/mobile IT/digital IT	2017	17
An Adaptive Enterprise Architecture Framework and Implementation: Towards Global Enterprises in the era of Cloud/Mobile IT/Digital IT	2017	17
Strategy archetypes for digital transformation: Defining meta objectives using business process management	2020	16
Promoting digitally enabled growth in SMEs: a framework proposal	2020	12
Analysis of companies' digital maturity by hesitant fuzzy linguistic MCDM methods	2020	9

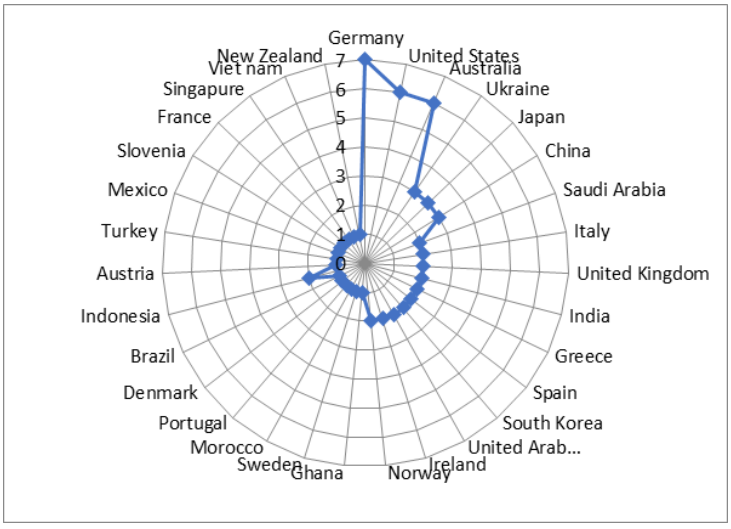
Regarding the scientific production by country, Figure 5 details the analysis carried out, 31 countries that have carried out research on the subject of study are identified, Germany leads the research with seven publications, followed by US and Australia with 6 each, Ukraine, Japan and China with 3 respectively, regarding participation together with other countries, Germany leads the ranking with 5 in Europe, followed by Australia with 3 in Oceania, US with 2 in America and UAE with 2, in addition to other initiatives jointly from Japan, China and South Korea in Asia. We can determine that the greatest interest in the subject is in Europe with 15 countries with scientific production on it, followed by Asia with 9 countries, America 3 and Africa and Oceania with 2 each.

Regarding the topics covered in the selected publications, the keywords used by the authors are reviewed and their frequency is calculated in order to identify the topics covered that are related to the research, 'digital transformation' is repeated 24 times, followed by 'cloud computing' with 4, 'higher education' and 'information systems' with 3, 14 keywords are counted that are repeated 2 times and 191 with one occurrence, there are many keywords that are related to the research topic which evidences the growth and importance of the Digital Transformation Implementation processes in universities. Table 4 shows the details of the keywords reviewed.

Table 4 Keywords used

Keyword	*Freq*
Digital transformation	24
Cloud computing	4
Higher education, information systems	3
COVID-19, ERP, digital maturity assessment, digital maturity, case study, digitisation, dynamic capabilities, maturity model, internet of things, digital, capabilities, project management, organisational change, information technology, enterprise architecture	2
Delone, adaptive learning, challenges, behavioural changes, cyber physical systems, assessment model, business ecosystems, business process management, advanced technology, digital parliament, a public management, concurrent engineering, expert locator, artificial intelligence, architecture board, business processes, AHP, delphi study, archimate modelling, collaboration, building construction, boundary spanning practice, business model, agile, mobile commerce, change management, digital transformation strategy, eap, data governance, heis, emis, educational organisation, computational thinking, decision support guide, digital transformation maturity, communal leadership traits, data analytics, distribution model, business models, digital governance, industry 4.0, knowledge management, bibliometrics, aras, information systems quality, ecosystem, front-end, semantic web, perception-based model, higher-education institution, holistic model, financial services, government, network economy, autopoietic social systems, peoplesoft, information quality, computer science, data integrity, ict, revenue model, business transformation, interview study, organisation change, industrial internet playground, disruptive technologies, iot, researcher finding, crm, smart product, innovation, management information systems, enterprise architecture framework, digitalisation, digital business ecosystem, technology framework, smes, institutional effectiveness, maturity assessment, multi-attribute model, information asset management, interpretive case study, public administration, collectively prevalent interpretants, devops, utaut, vertical plant wall, dilemmas, process assessment, leader behaviours, system of systems, intra-it alignment, digital services, meta objective, readiness assessment, knowledge-driven processes, project, growth, manufacturing, smart knowledge mapping, digital platforms, likoebe maruping, ea, sabine matook, hesitant fuzzy linguistic term sets, mixed methods, ui, productivity, Korean pop, digital innovation, knut rolland, technology adoption, learning management system (lms) selection, misalignment, small and medium-sized enterprises, information assets, is strategising, operational alignment, pandemic, Saudi Arabia, software development, software operation, mclean, technology adoption, education, managers, smart manufacturing, transdisciplinary engineering, maturity model, strategy archetype, the fourth industrial revolution, technology intervention, legal tech, smes, r&d knowledge, smart model, topic analysis, multi criteria decision making, software architecture, pervasive platforms, ui/ux, tam, organisational capabilities, Vietnam, lms implementation, regional parliament, severe moral communities, service quality, information technologies, word, transformational leadership, work 4.0, platforms, parliamentary administrators, project maturity, robotisation, enterprise mobile it, software process, smart cities, ux, software vendors, lms transition/migration, system quality, primary school, parliamentary hype cycle, global corporation, software quality, system pluggability, secondary school, parltech, solutions, integration	1

Figure 5 Scientific production by country (see online version for colours)



4 Analysis

4.1 Q1. ¿What digital transformation models can be used in universities?

The results obtained show twenty-three models that can be used in universities, each model starts from a different approach, but all aim to achieve Digital Transformation. Some are based on evaluation models to identify the capabilities of the organisation, this is justified since in the design of the business model of universities they do not prioritise technological processes (Coccoli et al., 2014), Other models are based on the acceptance of technology, which focus on achieving a change in the organisational culture that is deeply rooted in universities (Rodríguez-Abitia et al., 2021), models based on technological development are also observed. The details of the models found are shown in Table 5.

Table 5 Models to implement digital transformation in universities

References	*Model*	*Description*
Omar and Almaghthawi (2020)	Data governance model for universities	It is stated that due to the critical role of data in digitisation processes, data governance is essential for the digital transformation process in all organisations, the increase in data in all University operations is identified, deficiencies are evident in data governance policies and procedures, therefore, an operational model is formulated to face digital transformation from the perspective of data governance, the model consists of seven steps: (1) creation of a data governance team, (2) appointment of a Data Governance Auditor, (3) monitoring of regulatory compliance on data issues, (4) definition of priorities, (5) education and training, (6) definition of compliance and monitoring standards, and (7) evaluation

Table 5 Models to implement digital transformation in universities (continued)

References	*Model*	*Description*
Bamufieh et al. (2021)	ERP acceptance conceptual model	In the context of Information Systems Implementations for higher education institutions, attention is paid to Enterprise Resource Planning (ERP) Systems that integrate processes, functions and data in the organisation, existing problems in adoption are evidenced of these systems, for which a model based on the unified theory of acceptance and use of technology (UTAUT) is proposed, oriented towards the acceptance of an ERP, for which five basic criteria are defined to be considered: performance expectations, social influence, facilitating conditions, complexity and quality of the system
Ifenthaler and Egloffstein (2020)	Holistic technology adoption model	The work starts from the existing problems in the processes of adoption and integration of digital technology in educational organisations, the deficiencies of the current models in educational institutions are evidenced, for this reason a Holistic Model of adoption of digital technology is proposed, this model evaluates the maturity of the educational institution to adopt technologies, it is based on six dimensions: (1) equipment and technology, (2) strategy and leadership, (3) organisation, (4) employees, (5) culture, and (6) digital teaching and learning
Gökalap and Martinez (2021)	Digital transformation capabilities model	The model is built from a maturity model, dimensions that determine the state of the organisation are defined. The dimensions of the model are based on the categories of the Digital Transformation processes: (1) Strategic Governance, (2) Technology and Information, (3) Digital Process Transformation and (4) Personnel Management. Each of these categories defines key processes which also allow the generation of a roadmap for Digital Transformation
Hashmi et al. (2021)	Transdisciplinary system model adapted for X4.0	The model seeks to achieve the Digital Transformation taking into account the aspects of Industry 4.0 to generate an adaptation to other sectors, including the educational sector. The model considers four basic components to achieve Digital Transformation in different industries: (1) Cyber-physical Systems, (2) Data Analysis, (3) Data Integrity and (4) Work 4.0. These components represent the 3PE model (Product Process People Environment), on which the proposal is based
Zaoui and Souissi (2020)	ICT triaxial evaluation model	The proposed model is based on three axes to evaluate the capabilities of Information and Communication Technologies (ICT) as a preliminary phase to a Digital Transformation process. The model considers three dimensions as a basis for evaluating resources: (1) Technical, (2) Technological and (3) Human, in the same way the model considers three criteria or axes: (a) Use, which refers to the people who use and operate ICTs, (b) Content, referring to the Software and applications that allows access to data and services and (c) Access, referring to the existing infrastructure (hardware, connectivity and computing devices)

Table 5 Models to implement digital transformation in universities (continued)

References	*Model*	*Description*
Blyznyuk et al. (2021)	Maturity Model for public administration	Within the framework of the modernisation of public administration, it is necessary to determine the level of maturity of an institution in order to implement the Digital Transformation. An adaptation is proposed considering 8 key evaluation areas considered critical to implement Digital Transformation projects: (1) Content Management (2) Implementation Terms, (3) Implementation Costs, (4) Quality (5) Human Resources, (6) Media, (7) Risks and (8) Resources
Wu et al. (2021)	Four Tier AI Capabilities Model	A capabilities model is generated based on the study of Artificial Intelligence as a base technology for Digital Transformation processes, each capability is associated with types of technologies which allows identifying the base tools for these processes, the model considers the following capabilities: (1) Computer applications, (2) Algorithms, (3) Connectivity and (4) Data collection and transmission
Maciá Pérez et al. (2021)	IT Strategic Project Portfolio Model	The model allows implementing the portfolio of projects considered strategic within the framework of Information Technology (IT) with the aim of achieving Digital Transformation in Universities, the model considers from the conventional structure to a strategic structure where the following are contemplated axes or elements: (1) Strategic alignment of IT projects, (2) University strategy, (3) Requirements of IT projects, (4) Prioritisation of projects, (5) Management of IT projects, (6) Management of IT projects, (7) Pre-project analysis and (8) Product
Yang et al. (2021)	Model for the Digital Transformation of the innovation ecosystem	Mathematical model based on the agents that promote and generate the Digital Transformation considering digital innovations, the model develops an algorithmic logic to determine the economic impact of said agents, the following elements are considered: (1) agents, (2) iterations, (3) environment, and (4) processes
Russo et al. (2018)	Information Systems quality model	This work proposes the development of Software as a basis for the implementations of the Digital Transformation, emphasising the Quality of Information Systems, for which the ISO/IEC 25010:2011, ISO/IEC 42010:2011 and ISO/IEC standards are evaluated. 12207:2008 and a theoretical model of Information Systems Quality based on 3 axes is proposed: (1) Software Quality, (2) Software Architecture and (3) Software Processes
Cho and Kim (2020)	Collaboration-based UI/UX development improvement models	Within the framework of user interface (UI) design based on user experience (UX), it is necessary to guarantee collaboration between Information Systems developers and front-end service developers. In this context, an agile model is proposed that includes the following elements: (1) Strategy, (2) Expertis, (3) Design and (4) Support

Table 5 Models to implement digital transformation in universities (continued)

References	*Model*	*Description*
Berlak et al. (2021)	Evaluation model of the impact of digitisation on productivity	This model was adapted from the TAM2 technology acceptance model, thereby generating the expected evaluation model. This model considers the following factors: (1) Subjectivity of the standards, (2) Digitisation perspective, (3) Relevance, (4) Resistance, (5) Visibility of results, (6) Perceived usefulness, (7) Perceived usability, (8) Intention to use, (9) Uses of Digitisation, (10) Resources and (11) Efficiency
Schneckenberg et al. (2021)	Conceptual model of business model innovation	From the evolution of digital technologies, innovation strategies and IT services of companies have changed, in this context, service providers acquire a relevant role in creating value for companies, generating an innovation model enabled by cloud computing, the proposed model considers seven capabilities: (1) Customer-centric offerings, (2) Intensification of the relationship with the customer, (3) Development of technological capabilities, (4) Business flexibility (5) Dynamic Architecture, (6) Cash Flow Improvement, and (7) Adaptable Revenue Streams
Wiedemann et al. (2020)	IT alignment tripartite model	The work emphasises the DevOps method which integrates the tasks, knowledge and skills corresponding to the planning, construction and execution of activities in the software development processes, in this sense a model is generated that aims to achieve the operational alignment in the infrastructure and processes of Information Technology (IT), three alignment mechanisms are considered: (a) Integrated responsibility, (b) Individual component, and (c) Multidisciplinary knowledge
Chau et al. (2021)	Conceptual model for the adoption of mobile commerce	A model based on perception is proposed for the adoption of mobile commerce in SMEs, the proposal conceptualises three contexts: (1) Technological context, which considers benefits, compatibility and security. (2) Organisational context, which considers the organisation's readiness, cost adoption, and top management support. (3) Environmental context, which considers competitive pressure, customer pressure, and government support
Rodríguez-Abitia et al. (2021)	Integrated multidimensional model of digital transformation	An integrated digital transformation model is proposed to evaluate the level of maturity that educational institutions have in their digital transformation processes, this model considers five organisational dimensions: (1) Digital Strategy, (2) Culture and Leadership, (3) digitalisation of the market, (4) Strengthened logistics, and (5) Dynamic and digital capabilities. These dimensions converge with the transformational objectives that can be grouped into: (a) Value creation, (b) Technological benefits and (c) Structural agility. At the same time, the financial viability and the support to give way to Innovation are considered

Table 5 Models to implement digital transformation in universities (continued)

References	*Model*	*Description*
Borštnar and Pucihar(2021)	Multi-attribute model for the evaluation of digital maturity	A multi-attribute model is proposed for the evaluation of the digital maturity of an SME, for these two basic dimensions are considered: (a) Digital Capacity, which includes among its attributes: digital technology, the role of information technology, the digital business model and strategy, (b) Organisational Capacity, which includes among its main attributes: human resources, organisational culture and administration
Evans and Price (2020)	Holistic Information Asset Management Model (HIAM)	The proposed model considers as a principle that digital transformation (DT) requires more than technology, data, information and knowledge must be managed as assets, based on this principle the proposal considers holistic information asset management (HIAM) and defines 10 domains that represent the important areas or practices that the organisation should consider: (1) Business Benefits, (2) Business Environment, (3) Executive Awareness, (4) Leadership and Management, (5) Environment, (6) Systems Information, (7) Behaviour of information, (8) Information attributes/Quality, (9) information performance, and (10) Justification
Chanias et al. (2019)	Digital Transformation Strategy Model	A strategy model is proposed to achieve Digital Transformation, the model considers among its components: (1) the enthusiasm of customers to generate new digital products and services and digitise existing products and services, (2) the digital skills to achieve the use of data and greater flexibility of the infrastructure, in addition, the Digital Transformation strategy is proposed in two parts: strategic direction and resources
Hilabi et al. (2021)	Enterprise architecture model	Within the framework of Digital Transformation, a Business Architecture Model oriented to government administration is designed, this model considers the following views for its implementation: (1) Business View, (2) Computational View, (3) Information View, (4) Engineering View and (5) Technological View
Suray et al. (2020)	Conceptual model of public administration quality	A transformation model of public administration is proposed, considering digitalisation as the basis of transformation, good governance and new public policies are conceptualised as the basis for achieving the quality of public administration, aspects to be taken into account are considered, such as: Reduction of public spending, Growth of powers of state power for the formation and implementation of public policies. Improve the quality of state performance of functions as an employer, among others
Parra et al. (2021)	Social systems model	A model is proposed to represent and exemplify how information and communication technologies (ICT) allow the emergence of moral communities, with different points of view. The model seeks to promote digital resilience considering an operating domain and a generic domain, which in turn consider the individual and collective part of each member of the community

4.2 Q2. ¿What digital transformation framework can be used in universities?

The frameworks obtained have a holistic or systemic approach, since they consider in an integrated way all the relevant aspects for the achievement of the Digital Transformation, therefore they define dimensions, blocks, elements, components or processes that must be achieved or executed, in this sense, some studies define an operating model and name it as a reference framework. (Westerman et al., 2011) which is common in many implementations and framework proposals. It is noted that some frameworks focus on: capacity assessment (Demartini et al., 2020; Marks et al., 2020; Amaral et al., 2021; Aagaard et al., 2021), enterprise architecture (Masuda et al., 2017, 2018; Bondar et al., 2017; Korachi and Bounabat, 2019), ecosystems (Tan et al., 2020) and the operating process (Amaral et al., 2021; Korachi and Bounabat, 2019; Liu et al., 2021; Venkatesh et al., 2019; Koryzis et al., 2021; Büyüközkan and Güler, 2020). The digital technology and digital strategy components are the basis of all the proposals, followed by the training component as the most important. The detail of the frames is shown in Table 6.

Table 6 Framework that can be used in universities

References	*Frameworks*	*Components/elements/dimensions*
Marks et al. (2020)	Digital Transformation Assessment Framework for Higher Education	(1). Vision of Digital Transformation: strategy, leadership and communications, (2). Talent for Digital Transformation: skills and knowledge, (3). Digital Transformation processes: Control and digital technology, (4). Approach and understanding with the client
Liu et al. (2021)	Digital Transformation Framework	(1). Innovation. Spaces for innovation, principles of innovation, (2). Technology. Technical requirements: Connectivity, computation, intelligence and (3). Business. Definition of Characteristics: business model, updating of the business model, profile of new products
Demartini et al. (2020)	Assessment Framework for Digital Transformation	Main Processes: (a). Infrastructure and devices. Technological infrastructure, information infrastructure, equipment, services, etc., (b). Training for trainers. Teaching and learning of Processes, support services, service administration, and (c). Analysis. Data management. Support processes: (a). Management of the organisation, (b). Management of standards, rules and regulations, (c). Training management and (d). Management of the life cycle of the Digital Transformation
Venkatesh et al. (2019)	Framework with a focus on digital service providers	(1). Communication with the service provider, (2). Enable digital services, (3). Digital service provider, (4). Future provider of digital services and (5). Digital transformation as a service
Amaral et al. (2021)	Evaluation framework with a focus on production	(a). People, (b). Production processes, (c). Technology, (d). Smart products, (e). Organisation and (f). Changes
Aagaard et al. (2021)	Digital Maturity Assessment	(1). Strategy, (2). Culture, (3). Organisation, (4). Processes, (5). Technology and, (6). Clients and Partners

Table 6 Framework that can be used in universities (continued)

References	*Frameworks*	*Components/elements/dimensions*
Koryzis et al. (2021)	Parliamentary Digital Transformation Framework	Base components: (a). Strategy, (b). Operations, (c). Technology and (d). Digital Transformation. Dimensions: (a). User need and technological trend. Person, culture, structure, data, processes and information systems, y (b) Needs of society. Collaborative business processes, communication and engagement with citizens, openness, inclusion and accessibility
North et al. (2020)	IT-enabled business transformation framework	(1). Detect digitally enabled growth potentials. (2). Develop a digitally enabled growth strategy and mindset. (3). Harnessing digitally enabled growth potentials and (4). Resource management for digital transformation
Masuda et al. (2017, 2018)	Adaptable Integrated Framework of enterprise architecture	(a). Vision and definition of Architecture. (b). Business architecture. (c). Information system architecture. (d). Technological architecture. (and). Opportunities and solutions. (f). Migration planning. (g). Implementation governance (h). Architecture change management and requirements management
Büyüközkan and Güler (2020)	Decision framework	It considers 4 aspects that in turn are subdivided into 7 levels each in order to determine the most important criteria to take into account in the Digital Transformation processes: (1) Culture, (2) Organisation, (3) Technology and (4) Knowledge
Tan et al. (2020)	A framework for the development of business ecosystems	It is based on three stages: (a). Production: Use of Information Technology (IT) to modify and alter products; (b). Plataformisation: Using IT to create and share distribution channels and (c). Democratisation: IT to reshape and foster new capabilities through the development of social networks and mobile applications
Bondar et al. (2017)	Zachman's frame	It is based on a layered architecture: (1). Scope, (2). Business model, (3). System model, (4). Physical/technological model, (5). Detailed representation and (6). Operation of the company
Korachi and Bounabat (2019)	Integrated framework for the construction of digital transformation strategies	It presents two dimensions: (1). Construction of digital strategies, which is divided into 9 blocks: (a) Business strategic planning, (b) IT strategic planning, (c) IT organisational structure, (d) IT reports, (e) IT Budget, (f) IT Investment Decisions, (g) Steering Committee, (h) IT Prioritisation Processes, and (i) IT Responsiveness. These blocks in turn give life to 34 processes. (2). Evaluation of the Digital strategy, which is divided into four blocks: (a) Definition of key performance indicators, (b) Evaluation of the level of maturity of the digital transformation, (c) Represent the key performance indicators in a Dashboard and (d) Control the evolution of the digital transformation

4.3 Q3. ¿What digital transformation roadmap can be used in universities?

The review shows eight Roadmaps that can be used in universities, the Digital Transformation roadmaps define and specify the processes and tasks to be executed to

achieve the process, in this sense they are broader and more technical, they can be divided into: strategic, tactical and (Heavin and Power, 2018), they can also be associated with certain approaches (Barbosa et al., 2020; Rachinger et al., 2019; Fischer et al., 2020) or define general pillars similar to a model (Doukidis et al., 2020). Table 7 shows the roadmaps found that can be used by universities.

Table 7 Roadmap to implement digital transformation in universities

References	*Roadmap*	*Steps/stages*
Heavin and Power (2018)	Digital transformation decision guide for managers	(1). Strategic tasks. Establish digital leadership, reinvent the business model, rethink business processes, redefine stakeholder engagement, define the digital government strategy. (2). Tactical tasks. Develop digital management capabilities, Digitise the business process/create new digitised business processes, establish digital government processes, manage performance and integrate the business with information technologies. (3). Operational tasks. Attention to new digital technologies, explore new databases, identify qualified key personnel, identify data integration opportunities, implement digital government controls
Gökalap and Martinez (2021)	Roadmap for the improvement of the maturity of the Digital Transformation	(1). Develop the digital transformation strategy. (2). Manage the project portfolio. (3). Develop skills in human resources. (4). Manage the Organisational Structure. (5). Manage projects. (6). Manage financial resources and suppliers. (7). Manage IT strategy. (8). Definition of requirements. (9). Develop Enterprise Architecture. (10). Manage infrastructure. (11). Embrace Data Governance. (12). Perform Agile Software Development. (13). Manage Security. (14). Integrate enterprise architecture. (15). Perform Vertical Integration of Business Processes. (16). Manage Organisational Change. (17). Manage Sustainable Learning over time. (18). Perform Horisontal Integration of Business Processes. (19). Perform Data Driven Decision Management. (20). Perform Quantitative Performance Management. (21). Perform data analysis. (22). Perform Enterprise Architecture maintenance. (23). Carry out self-optimised decision management. (24). Carry out the integration of business processes towards the life cycle. (25). Carry out the quantitative improvement of the process
Philip (2021)	Planned and forced digital transformation	(1). Creating a new vision and innovative Ideas (Structural Changes): (a). Update of digital tools, (b). Updating of business processes and (c). Update of operating procedures. (2). Motivate and provide an enabling environment (Behaviour Changes). (a). Generate behaviour changes

Table 7 Roadmap to implement digital transformation in universities (continued)

References	*Roadmap*	*Steps/stages*
Fischer et al. (2020)	Recommendations for the design of digital transformation projects using BPM	(1). Define goals for the digital journey. (2). Define governance and compliance mechanisms. (3). Ensuring management support. (4). Establish a suitable interaction model. (5). Provide a process architecture to coordinate and integrate distributed efforts. (6). Provide an educational program. (7). Establish process-oriented knowledge management. (8). Provide adequate support for tools. (9). Integrate the IT infrastructure. 10, Integrate improvement initiatives. (10). Facilitate stakeholder collaboration. (12). Define conventions and guidelines to support or regulate process modelling and process interoperability. (13). Manage versions and variants of models. (14). Develop a comprehensive communication plan. (15). Secure stakeholder engagement. (16). Guarantee adequate ease of use. (17). Facilitate process orientation
Barbosa et al. (2020)	Roadmap for robotisation processes	Plan: (a). Training of work teams, (b). Evaluation of current processes, (c). Check the roadmap. (d). ROI analysis (return on investment)
		Do: (a). Stakeholder Support, (b). Project planning, (c). Determine the type of automation, (d). Staff training, (e). Developing y (f). Deployment. Check: (a). Tests, (b). Check results, (c). Comparison with the established objectives, (d). Process monitoring and (e). Identify Settings. Act: (a). Put into production and update the new processes and (b). Standardise, continuous improvement
Rachinger et al. (2019)	Ideas for business model innovation (BMI)	Planning level: (1). Define the Strategy, (2). Develop dynamic capabilities. Architecture Level: (1). Define the business model ad (2). Innovate the business model. Implementation level: (1). Generate Business Processes
Doukidis et al. (2020)	Pillars of Digital Transformation	(a). The transformation of the customer experience, (b). The transformation of business processes, (c). The transformation of the business model and (d). The transformation of the organisation
Chanias et al. (2019)	Digital Transformation Strategy	(1). Recognition of the need for Digital Transformation, (2). Preparation of the Scenario, (3). Initial Formulation of the Digital Transformation strategy, (4). Preparation of the implementation of the Digital Transformation strategy, (5). Start of the Implementation of the Digital Transformation strategy, (6). Definition of the work model, (7). Improved Digital Transformation Strategy

5 Discussion

The specialised literature shows that Digital Transformation is not a process that is born or structured from a common baseline, the diversity of models is due to the type and need of each organisation. In this sense, we can affirm that there are different starting points but all of them have the objective of achieving Digital Transformation. The findings show that each model and framework have been built from different approaches or points of view. Regarding the models found the following are considered: data governance (Omar and Almaghthawi, 2020), technology acceptance (Ifenthaler and Egloffstein, 2020; Bamufieh et al., 2021; Berlak et al., 2021; Chau et al., 2021), organisation capabilities (Gökalap and Martinez, 2021; Zaoui and Souissi, 2020; Blyznyuk et al., 2021; Wu et al., 2021; Borštnar and Pucihar, 2021; Rodríguez-Abitia et al., 2020), industry (Hashmi et al., 2021), projects management (Maciá Pérez et al., 2021), ecosystems (Yang et al., 2021), Information Systems Development (Russo et al., 2018; Cho and Kim, 2020), business model innovation (Schneckenberg et al., 2021), enterprise architecture (Wiedemann et al., 2020; Hilabi et al., 2021), asset Management (Evans and Price, 2020), strategy (Chanias et al., 2019), quality of public management (Suray et al., 2020) and social (Parra et al., 2021).

Based on the answers to questions one and two, the components that are part of the different models and frameworks are analysed to define common aspects that can be related to digital transformation for universities, the following components are identified to be taken into account:

1 Strategy, refers to the use of strategy in planning tasks, in informatisation (Cho and Kim, 2020) in the management and strategic alignment of Information Technologies (Maciá Pérez et al., 2021), digital strategy is considered (Rodríguez-Abitia et al., 2021) associated with leadership and management (Ifenthaler and Egloffstein, 2020) and integrated responsibility (Wiedemann et al., 2020) of the organisation, which must converge in a strategic governance (Gökalap and Martinez, 2021) data-driven to improve decision-making (Omar and Almaghthawi, 2020; Hashmi et al., 2021; Blyznyuk et al., 2021; Wu et al., 2021).

2 Technology, the entire technological context is considered as a facilitator of digital transformation processes (Bamufieh et al., 2021; Zaoui and Souissi, 2020; Chau et al., 2021) although another approach refers to information technologies as a whole (Gökalap and Martinez, 2021), More specifically, technological infrastructure and cyber-physical devices are mentioned (Ifenthaler and Egloffstein, 2020; Hashmi et al., 2021), digitisation and its perspective (Rodríguez-Abitia et al., 2021; Berlak et al., 2021; Suray et al., 2020), information systems, computer applications (Wu et al., 2021), software architecture (Russo et al., 2018), enterprise dynamic architecture (Schneckenberg et al., 2021), computer vision (Hilabi et al., 2021), market digitisation and digital logistics (Rodríguez-Abitia et al., 2021), digital resilience (Parra et al., 2021) and technology support (Cho and Kim, 2020).

3 Norms and standards, associated with regulations, rules, principles and policies to follow (Omar and Almaghthawi, 2020; Berlak et al., 2021; Suray et al., 2020).

4 Training, includes the teaching-learning processes so that the organisation as a whole achieves Digital Transformation (Ifenthaler and Egloffstein, 2020; Omar and Almaghthawi, 2020), it is also defined as the acquisition of techniques and new

knowledge (Zaoui and Souissi, 2020), the generation of skills by the staff (Cho and Kim, 2020), generation of dynamic and digital skills (Rodríguez-Abitia et al., 2021; Schneckenberg et al., 2021; Borštnar and Pucihar, 2021), acquisition of multidisciplinary knowledge (Wiedemann et al., 2020), generation of new digital skills (Chanias et al., 2019) and the growth and development of competencies (Suray et al., 2020).

5 Quality, refers to the quality of the system, process, software development processes and performance as a whole (Bamufieh et al., 2021; Blyznyuk et al., 2021; Russo et al., 2018; Suray et al., 2020).

6 Organisation, defines the context of the organisation to face the Digital Transformation process, the facilitating conditions are included (Bamufieh et al., 2021), organisation and organisational culture (Ifenthaler and Egloffstein, 2020), human resource management (Omar and Almaghthawi, 2020; Gökalap and Martinez, 2021; Zaoui and Souissi, 2020; Blyznyuk et al., 2021; Yang et al., 2021), leadership approaches and good governance (Rodríguez-Abitia et al., 2021; Suray et al., 2020), the individual and collective components (Wiedemann et al., 2020; Parra et al., 2021), the capacity of the organisation and the business approach (Hilabi et al., 2021).

7 Social, focuses on meeting the needs of society from the generation of services and products (Bamufieh et al., 2021), includes project requirements (Maciá Pérez et al., 2021), the participating agents and the environment where it is developed (Yang et al., 2021), customer focus (Schneckenberg et al., 2021; Chanias et al., 2019), and the definition of public policies for the benefit of the client or end user (Suray et al., 2020).

8 Processes and business, the structuring of digital processes is considered (Gökalap and Martinez, 2021), establishment of working approaches (Hashmi et al., 2021), interaction flows between processes (Yang et al., 2021), media and communication channels (Wu et al., 2021) business characteristics such as flexibility (Schneckenberg et al., 2021), product design and generation (Maciá Pérez et al., 2021; Cho and Kim, 2020), performance expectations (Bamufieh et al., 2021)and the costs associated with the business (Schneckenberg et al., 2021). The general mapping of the studies related to the identified components is shown in Table 8.

The identified components abstract the different elements, dimensions and parts considered in each model and framework, an analysis is made of the existing relationships between each one based on the proposals and experiences described in each work, it is identified that the strategy component is the basis for generating regulations and standards, defining the technological aspects and generating the processes of generating skills or training for the implementations of the Digital Transformation, the generation of regulations is the basis for establishing quality standards in the processes and structure of the business, also for technological aspects in general, technology is the basis for achieving training, organisational management, the development of operating processes, the business model and the issuance of services and products for society, quality defines the way in which the processes and the business will be implemented, in the same way it regulates the technological processes the processes and the business are the basis for the achievement of the objectives towards the clients and final users who

represent the social part, organisational management is responsible for the training processes in general and for maintaining, optimising and executing the operational processes and the business model, It is also responsible for the way in which its products and services are issued to customers and end users. These components and their relationships can be understood as functional dependencies and can serve as the basis for the generation of a Digital Transformation model for any organisation, including universities. The diagram in Figure 6 shows the relationships found.

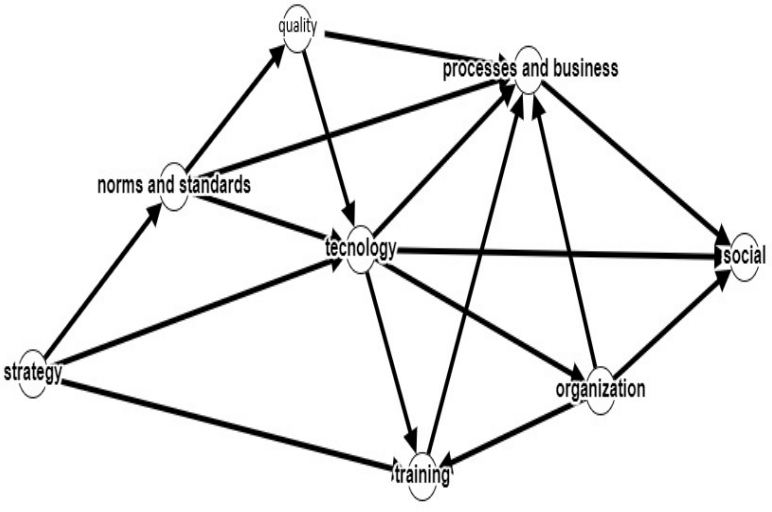
Table 8 Components identified in the models and frameworks

References	*Strategy*	*Technology*	*Norms and standards*	*Training*	*Quality*	*Organisation*	*Social*	*Processes and business*
Omar and Almaghthawi (2020)	x		x	x		X		
Bamufieh et al. (2021)		x			x	X	x	x
Ifenthaler and Egloffstein (2020)	x	x		x		X		
Gökalap and Martinez (2021)	x	x				X		x
Hashmi et al. (2021)	x	x						x
Zaoui and Souissi (2020)		x		x		X		
Blyznyuk et al. (2021)	x				x	x		x
Wu et al. (2021)	x	x						x
Maciá Pérez et al. (2021)	x						x	x
Yang et al. (2021)						x	x	x
Russo et al. (2018)		x			x			x
Cho and Kim (2020)	x	x		x				x
Berlak et al. (2021)		x	x					
Schneckenberg et al. (2021)		x		x			x	x
Wiedemann et al. (2020)	x			x		x		
Chau et al. (2021)		x				x		
Rodríguez-Abitia et al. (2021)	x	x		x		x		
Borštnar and Pucihar (2021)				x		x		
Evans and Price (2020)	x	x		x	x	x		
Chanias et al. (2019)				x			x	
Hilabi et al. (2021)		x				x		
Suray et al. (2020)		x	x	x	x	x	x	
Parra et al. (2021)		x				x		
Marks et al. (2020)	x	x		x	x		x	x
Liu et al. (2021)	x	x						x
Demartini et al. (2020)	x	x	x	x		x	x	x
Venkatesh et al. (2019)	x	x					x	x
Amaral et al. (2021)	x	x				x	x	x

Table 8 Components identified in the models and frameworks (continued)

References	*Strategy*	*Technology*	*Norms and standards*	*Training*	*Quality*	*Organisation*	*Social*	*Processes and business*
Aagaard et al. (2021)	x	x				x	x	x
Koryzis et al. (2021)	x	x				x	x	x
North et al. (2020)	x	x		x		x		
Masuda et al. (2017, 2018)	x	x			x			x
Büyüközkan and Güler (2020)		x		x		x		x
Tan et al. (2020)		x		x			x	x
Bondar et al. (2017)		x				x		x
Korachi and Bounabat (2019)	x	x			x	x		x

Figure 6 Dependency relationships between components



6 Conclusions

The identified findings show that digital transformation processes are not homogeneous, there are various forms and approaches in their generation and development. The different models identified are based on the reality of the institution, therefore it is valid to start the process with a capacity assessment model.

The identified frameworks generate operational models to follow that are easily associated with operational tasks which can be structured in roadmaps which detail the process step by step, there are multiple approaches, therefore the technological state of the institution must be previously defined. Define the existing digital capacities and the objectives of the process, these will allow generating the digital strategy to follow.

It is evident that many aspects or elements studied can be grouped into a single category since in their conceptualisation they define the same thing: digitisation with technological implementations, strategic management with strategic government, data governance with strategic data, quality management with institutional quality, etc., it is concluded that there are components and elements that are used in the same way in the structuring of a model and a framework, this enables the identification of common components for a Digital Transformation process, which allows defining primary components and dependency associations, which they are the basis for generating new and better Digital Transformation models for universities.

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