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Assessing Digital Transformation in Universities

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Abstract: Industry 4.0 and Society 5.0 are reshaping the way organizations function and interact with the communities they serve. The massive penetration of computer and network applications forces organizations to digitalize their processes and provide innovative products, services, and business models. The education market is suffering changes as well, but universities seem slow to react. This paper proposes the application of an integrated digital transformation model to assess the maturity level that educational institutions have in their digital transformation processes and compares them to other industries. Particular considerations to address when using the model for higher-education institutions are discussed. Our results show that universities fall behind other sectors, probably due to a lack of effective leadership and changes in culture. This is complemented negatively by an insufficient degree of innovation and financial support.

Keywords: digital transformation; maturity assessment; higher-education institution

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1. Introduction

In the knowledge era, it is ever more important to understand the value that information technology (IT) initiatives may bring to organizations. Some industries have been severely reshaped as a consequence of the introduction of value added to products and services through technology applications. Such is the case for the entertainment industry, especially in the form of downloadable on-demand products based on subscription models, rather than the direct purchase of physical means for reproduction. Rationalized and flexible manufacturing with enhanced logistics services have also played a major role in the competitive arena for heavy production industries. IT has also enabled integrated value chains and personalized products and services. As we move deeper into the Fourth Industrial Revolution, emerging and disruptive technologies like the Internet of things (IoT), three-dimensional printing, big data and analytics, machine learning and other forms of artificial intelligence, and cyber-physical systems increase their impact on the creation of streamlined, flexible processes and innovative business models.

Many terms have been used and have evolved to describe this value provision evaluation, from IT maturity to digital transformation along with e-readiness. However, the evolution has been slow, starting with simple studies on the profitability of establishing an IT infrastructure and moving all the way to the concept of digital transformation.

This phenomenon has been somewhat slower with regard to universities, as traditional education has been favored by professors, at least before the advent of the COVID-19 pandemic. It is important to recognize that blended-learning models and online education have already experienced a great deal of evolution since the inception of these schemes a few decades back, but their level of appropriation varies greatly from one institution to another.

This research seeks to review the most important models that have emerged and evolved to the present day in the business and organizational arenas, now that we are

immersed in the realm of Industry 4.0 and Society 5.0. Considering the premise that universities and higher education institutions are organizations as well, the model should fit them correctly when providing the appropriate contextualization. An integrated digital transformation model is proposed, and an instrument to assess its state in a particular organization is applied to some universities. Measuring its level of maturity would first provide a higher-education institution with a comprehensive view of where they stand on the road to digital transformation, as well as the necessary steps to follow in order to better profit from the intelligent use of IT that takes into consideration the opportunities and challenges of a dynamic competitive environment. This roadmap to digital transformation has the ability to help them plan pertinent actions to incrementally climb to higher levels of maturity and IT leverage and to achieve their organizational objectives.

The particular nuances that need to be addressed in an educational environment, particularly for higher education, are then identified and discussed.

1.1. Business Computing and the Productivity Paradox

In the late 1980s, it was observed that the productivity growth rate at the national level decreased, despite making heavy investments in IT and the fact that developments in IT were achieving exponential growth in processing power. This was defined as the productivity paradox. In 1993, Erik Brynjolfsson published a classic paper where he asserted that the relationship between IT and productivity was not well understood [1]. Brynjolfsson credited the decrease in productivity rates to errors in measurement and methodological tools, as well as to mismanagement of the development and use of IT. Other possible explanations included the redistribution of activities among firms that allowed for firm-specific rather than industrywide gains or a delay in the returns, giving the false impression that the IT investment was not paying off. Measuring the benefit obtained from IT could not be viewed from a single point of view, and it should be considered a matter of properly aligning organizational objectives with the implementation and use of IT.

1.2. IT Planning and Strategic Alignment

Many models emerged which tried to provide a framework to help plan IT functions in organizations. One of the classic ones is the information systems architecture model proposed by Zachman [2]. This model attempted to provide an integrated framework of IT planning and development, where data, processes, and business functions were taken into consideration in a synergic way and from different organizational levels or perspectives. Many of the techniques integrated in the model were commonly used already in IT functions, such as data flow diagrams and database modeling.

Other planning models emerged from the management discipline and were incorporated or adapted for providing an alignment tool between IT and business strategy. That was the case for the balanced scorecard method developed by Kaplan and Norton [3], whose cause–effect diagrams allowed for a practical tool to insert IT projects and attain business goals.

As time passed, the concept of alignment became more relevant, and two models stand out in the literature. The first one is the strategic alignment model from Henderson and Venkatraman [4]. They developed a model that included the relationships between organizational and IT infrastructure and processes, as well as between organizational and IT strategies. On the other hand, there was a model developed by Luftman [5] where the concept of maturity of the IT–business alignment was introduced, allowing for the identification of pertinent steps for an organization to grow and evolve in its alignment, thus favoring the appropriate contribution of IT to the company's strategy. This model included five levels of maturity based on the level of mutual understanding and objectives or risk sharing, governance issues, and enabling factors.

1.3. E-Readiness and Digital Maturity

Afterward, the alignment concept was modified again, and the terms e-readiness and digital (IT) maturity emerged. E-readiness was originally thought of as the level to which a country was able to benefit from the implementation and use of information and communications technology (ICT) to foster development. This concept was then brought down to the organization level, understood first as the level to which a company was prepared to engage in electronic commerce [6]. However, the term was later expanded to other applications of IT in the organization, understood then as the ability to take advantage of IT to enable its business processes and strategy. At times, e-readiness is still used at the country level, whereas it is referred to as IT capability at the firm level. When this capacity is understood to have a potential evolution, it may be called digital maturity. Venkatraman [7] developed a model of IT-enabled business transformation, clearly implying the dynamic and evolving nature of the IT impact on businesses.

1.4. Digital Transformation

The notion of digital transformation has gained momentum in the last decade. It departs from the previously mentioned concepts because not only does it attempt to measure the extent to which an organization is able to benefit from the use of IT, but it is also seen as an evolutionary process through which IT becomes a fundamental element of its daily life, affecting all dimensions that involve both people and the organization itself.

Nevertheless, there is a great variety of interpretations of digital transformation in the existing literature. To some, it is only an application of IT to business processes [8]. These authors use an incremental approach with respect to prior applications. In fact, they base their work strongly on Venkatraman's model of IT maturity.

Others consider digital transformation to be something much more dramatic and disruptive, capable of generating chaos in the business world [9]. However, these authors consider digital transformation a result of small but continuous digital innovations undertaken at the firm level which permeate to the industry level and, from there, to an industrial ecosystem. Digital transformation is therefore achieved as a function of accumulating digital innovations.

Perhaps one of the most balanced definitions describes it as an evolutionary process that takes advantage of digital capabilities and technology to enable business models, operational processes, and consumer experiences that generate value [10].

It is not uncommon to find the terms digitization, digitalization, and digital transformation used interchangeably without distinction. Digitization is generally understood as plain automation, providing the appropriate information systems to operate processes as they are. In some cases, digitalization and digital transformation are considered the same [11], whereas others consider the latter concept related to a profound reshaping of the organization based on IT [12]. Furthermore, the concept of digitalization may be defined as IT-enabled transformation. Digital transformation and IT-enabled transformation are different but related concepts. Both concepts address the effect of leveraging information technology on the value proposition. However, the focus of digital transformation is on its definition, while IT-enabled transformation is centered on supporting it. Additionally, digital transformation is involved with the creation of a new organization's identity, whereas IT-enabled transformation relates to the enhancement of an existing identity [13].

Digital transformation can also be viewed from the perspective of the relations among changes in structure, strategy, and technology to help respond to the needs imposed by a digital environment [14], stressing the need to balance between the old and new elements of the organization.

Digital transformation strategies are also innovation strategies that focus on product and process transformation, as well as other organizational issues, thanks to the use of new technology. These include the interaction between the user and the technology as a component of the product or service, and this allows for defining products, services, and business models in a joint fashion [15]. These authors stated that there must be a balance

among four transformational dimensions: changes in value creation, structural changes, the use of technology, and the financial aspects. They further built on their 2015 model by providing 11 questions to guide in the creation of a digital transformation strategy. Each question is detailed into elements that help assess the actions needed to design the strategy [16]. Rossman [17] frames a digital maturity model based on the development of capacities in multiple dimensions. These dimensions include different aspects of strategy, leadership, the market, operations, people and skills, culture, governance, and technology. However, the inclusion of innovation in an explicit manner is very marginal, and it seems to have too much of an incremental trend, rather than a disruptive one. Additionally, there is no mention of what could not be done without technological competencies and capabilities.

In agreement with the previous multidimensional proposals, Osmundsen et al. [18] attempted to identify the components of digital transformation and classify them according to their natures in four categories: drivers, objectives, success factors, and implications.

Muehlburger et al. [19] developed a framework drawing from an extensive review of the existing models, including nine enabling factors that were classified into four categories related to organizational values, management capabilities, organizational infrastructure, and workforce capabilities. These categories were, in turn, mapped directly to a normative, strategic, tactical, and operational layer, accordingly. The nine enablers that they included in their model were innovative organizational culture, internal and external collaboration, strategic embeddedness, digital leadership, digital platform structures, bimodal IT structures, institutionalized innovation processes, individual creativity and innovative capabilities, and information and communications technology (ICT) literacy. This model was refined and applied to German organizations for validation [20].

Gurbaxani and Dunkle [21] emphasized the importance of providing guidance to managers on how to assess their level of advancement in digital transformation efforts. They proposed a six-dimensional model that included strategic vision, the culture of innovation, know-how and intellectual property, digital capabilities, strategic alignment, and technology assets. Their measurements were self-reported by managers, and they were based on placing each dimension's progress in their particular companies, compared with that of the competition. The results varied greatly, depending on the activity of the company.

This leads to the belief that contextual factors may be of great importance. These can be related to location, size, or industry. From the perspective of Kääriäinen et al. [11], digital transformation is necessary for competitiveness, and large companies seem to embrace it well, while small and medium enterprises (SMEs) struggle. They understood digital transformation as being multidisciplinary. They also proposed tools to use the positioning phase of a digital transformation model to analyze the current status of a particular SME and provide recommendations to improve digitalization. This was done based on a cyclic implementation, review, and roadmap definition.

Digital transformation may have particular industry-specific nuances as well, based on aspects like hardware intensity [12]. They focused their work on deepening the knowledge of the manufacturing industry, which lent itself greatly to the use of heavy machinery. They believed hardware-independent industries were more prone to being reshaped by digital transformation than purely physical industries like manufacturing.

According to Wade et al. [22], studies in the literature showed that the aggregate rate of failure of digital transformation projects was 87.5%. Failure was interpreted as not achieving the expected return on investment. The causes of failure could be identified as unrealistic expectations, a limited scope, and poor governance. The priority for digital transformation significantly increased as a result of the COVID-19 pandemic. They claimed that the organizations that performed better were those with a certain level of digital maturity. In addition, they identified factors for success that included familiarity with home office practices, availability and maturity of technology, and not needing to convince people that a change is necessary. The digital transformation objectives need to be precise, realistic, inclusive, succinct, and measurable.

It is reasonable to believe that industry and size-specific differences may yield to implementation problems when not considered in the initiative. This may also prove true when workforce elements are not factored into the planning. Digital transformation requires workforce transformation. This implies changes in culture and capabilities. This process can be aided by IT at different levels, depending on the degree to which the technology is used, in three ways: responding to external pressures and demands with whatever resources and restrictions are available; truly leveraging IT to change the structure, roles, and capabilities; or even rethinking the profession and the need for a customer-centered orientation [23]. Moreover, digital innovation in an organization is greatly dependent on changing the way work is done and creating digital workplaces where the employees' experiences are improved. To achieve that, it is mandatory to address two dimensions: responsive leadership and employee connectedness [24].

1.5. ICT Use in Universities

The pace of higher education transformation has not kept up with the general shift in all other aspects of society. Kirschner [25] stated that technology use has been left to the discretion of the professor with little or no institutional support. She also mentioned that most scholars in the field accredited the slow reaction to an inertia that deterred innovation and change. Openness to change is a requirement for transformation. Universities face many challenges, including the decomposition of degrees into smaller open-source learning networks that can be credentialed will provide the skills needed for a job.

This atomic learning process seems to agree with the finely minced and popular pieces of knowledge acquisition tools available online, like open educational resources, or even those unsanctioned for content and academic quality, such as online videos.

Rodríguez-Abitia et al. [26] proposed a framework to assess the level of digital maturity in universities, based on their ability to provide an appropriate IT infrastructure (e.g., network connectivity, computing devices in labs or loan systems, equipped classrooms), apply technology to the teaching and learning process (e.g., open educational resources, interactive lessons, artificial intelligence and robotics, 3D platforms, repositories, and virtual simulators), and provide collaboration and organizational platforms to integrate processes and people (e.g., workflow systems, educational social networks, learning management systems integrated with academic administration systems, and virtual communities). The ability of universities to attain these objectives is severely restricted by contextual constraints in the political, social, and economic domains.

The Networked Readiness Index, published by the World Economic Forum, provides a general assessment of the state of countries, in terms of their ability to benefit from ICTs for improving their development and competitiveness, therefore significantly improving the quality of life of their inhabitants. This index has evolved over time, and it is currently comprised of four pillars that relate to technology, people, governance, and impact [27]. This framework is directly related to the United Nations Educational, Scientific and Cultural Organization (UNESCO)'s Sustainable Development Goals (SDGs), with quality education, where ICTs play a fundamental role, being fourth on the list [28].

An important challenge to promoting educational digital transformation is presented by the generational differences between the digital native students and the ICT-adopting faculty, posing a need for promoting a policy that enables both infrastructure and innovative learning environments to meet the needs of the Industry 4.0 and Society 5.0 eras [29]. This comes with the need for a large faculty training and awareness development component.

However, the characteristics of the so-called digital natives have been controversial material for extensive discussion among researchers. An analysis of what would be defined as the Google generation (born in 1993 or later) concluded that the concept that they were more web-literate than others could be overturned, since they could not critically assess the information retrieved. They did, however, show greater familiarity with and ease of use of computers and constant connectivity. They, however, are more competent in the use of technology, prefer interactive platforms over passive information consumption, have high

expectations of IT, prefer visual information over text, and tend to engage in plagiarism to a greater degree due to copy and paste availability, among many other findings [30].

This is consistent with a study [31] that found that the so-called digital natives, or the Net generation, are more intensive users of technology, especially the younger ones. Nevertheless, they use technology for informal purposes rather than academic ones. They are familiar and comfortable with ICTs, but they are not necessarily proficient at their use in different disciplines. They cannot be considered digitally literate only because they grew up in a digital environment. Other research works [32] go further to declare that evidence shows that there are no such things as digital natives, and they are not capable of performing multitasking just because they were born in a digital world. Assuming they are creates the risk of using learning models that do not help their education; instead, they deter their performance. Even if multitasking skills were effectively presented, there is indication that this characteristic may actually favor interference by irrelevant stimuli [33].

The COVID-19 pandemic has triggered a sense of urgency for organizations to digitalize to better cope with the challenges posed by it. The need for transformation was not alien to universities, where new models for delivery required profound changes in the educational process. Chen and Roldan [34] reported that challenges could be turned into opportunities with the appropriate tools and creativity. Thus, social interaction can be improved with digital means, electronic meeting and collaboration tools can help organize the work, and a greater pool of guest speakers and project evaluators can be reached worldwide. Yet, models need to be adjusted to meet the requirements of online delivery. Among many things, there is a need to foster student engagement, which can be easily lost or reduced compared with a face-to-face environment. Passing abruptly from a traditional setting to fully online delivery has not necessarily allowed for adapting the course to its new suddenly acquired nature. Establishing a rapport, generating communication links, and effectively using content are essential actions to make the student want to be involved and participate [35].

2. Materials and Methods

The present work was performed in three different stages. The first one was based on conceptual work, intended to merge the constructs of the different models reviewed so that one integrated digital transformation model could be derived. This was done by establishing equivalences among the different elements that composed the various models. Second, an instrument was created and validated to measure the resulting elements of the integrated model, which was then applied to some higher education institutions. Finally, a general assessment of the results was performed to determine the nuances required when applying the model to universities in particular, as opposed to any general organization. Conclusions from the previous steps are finally drawn and reported.

The general methodological framework is shown in Figure 1.

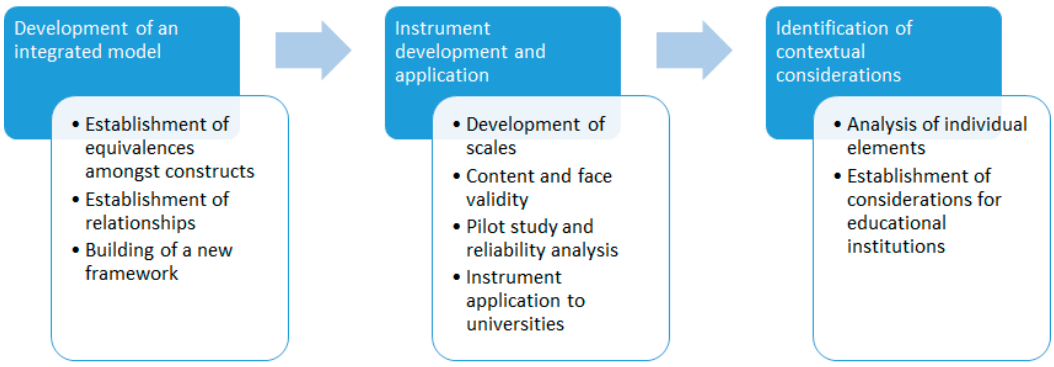

Figure 1. General methodology.

Even though certain components of this research are quantitative in nature, it is not the aim of this study to validate the relationships among the components of the model, but rather to provide a general framework to aid in the qualitative interpretation of the results. Thus, it is important at this stage to establish conceptual grounds for further exploration and later confirmation.

3. Results and Discussion

The results of the different stages in the methodology are described in the corresponding sections below.

3.1. Building an Integrated Model of Digital Transformation

It is possible to combine the features of the models reviewed so that one single useful and well-integrated framework can be obtained to explain the benefits gained from the use of IT in organizations, understood as the final goal of digital transformation.

For that purpose, the proposed model takes Rossman's model of digital maturity [17] as a starting point and maps its dimensions to the analysis perspectives of Osmunden et al. [18]. Thus, the strategic dimension may be related to the development factors of a digital business strategy and strategic alignment, as well as the implication of new business models.

On the other hand, the leadership dimension may be related to factors like organizational support, change management, and the engagement of managers and employees.

The market dimension, in turn, may be associated with the drivers of customer behavior and expectations, digital shifts in the industry, and changes in the competitive landscape. It can also be related to new business model implications with the leverage of internal and external knowledge factors (provided this is the basis for market intelligence) and with the objectives of digitally enhanced products, new business models, and digital channels.

Afterward, the dimension of operations is clearly related to the objective of product innovation practice appropriation, with the factor of dynamic capability growth and the implication of the effect on the outcome and performance.

The people and skills dimension is associated with the objective of ensuring digital readiness, with the factor of the growth of IT capacity and the development of dynamic capabilities, as well as the implication of the effect on the outcome and performance from the perspective of personal productivity.

The cultural dimension is associated with the factors of organizational support culture and the engagement of managers and employees. It also has to do with the objective of product innovation practice appropriation. Governance is related to the driver of regulation and with the factor of engagement of the managers and employees. Finally, technology is associated directly with the objective of ensuring digital readiness, the factors of IT capacity growth, development of dynamic capabilities, development of a digital strategy, and business alignment, together with the implication of reformed IT areas.

Coincidences can also be obtained from the digital enabling factors proposed by Muehlburger et al. [19,20]. Strategic embeddedness clearly fits into the strategic dimension, whereas digital leadership relates to the leadership dimension. Internal and external collaboration can be mapped to the market dimension, and for the operation dimension, there is a relationship to digital platform infrastructures, bimodal IT structures, and institutionalized innovation processes. The people and skills dimension is somewhat similar to individual creativity and innovation capabilities, as well as ICT literacy. Furthermore, the culture dimension has a clear match with innovative organizational culture. Finally, the governance and technology dimensions overlap with the elements that match the strategic and operations dimensions.

It is clear that such dimensions may be grouped together according to their level of coincidence. That is the case for the strategic and governance dimensions, as well as the leadership and cultural dimensions. A similar merge can be performed between the operations and technology dimensions, and some elements of the technology dimension

may also be incorporated into the strategic dimension. As a result, five final organizational dimensions were included in the model. These new grouped dimensions were defined as digital strategy, leadership and culture, market digitalization, strengthened logistics, and dynamic and digital capabilities. The new dimensions may be observed from three different perspectives, derived from the model from Matt et al. [15,16], according to their transformational objectives, which were named in our model as follows: value creation, technological benefit, and structural agility. Innovation and the financial aspect, which was treated marginally in these models, may be incorporated as cross-sectional aspects rather than as a single perspective or dimension, since they affect all the elements already considered. The mapping of elements is summarized in Table 1.

Table 1. Concept mapping from existing models.

Rossman (2018) [17]	Osmunden et al. (2018) [18]	Muehlburger et al. (2019) [19,20]
Strategic dimension	Digital business strategy Strategic alignment New business models	Strategic embeddedness
Leadership dimension	Organizational support Change management Engagement of managers and employees	Digital leadership
Market dimension	Customer behavior and expectations Digital shifts in the industry Changes in the competitive landscape New business models implication Leverage of internal and external knowledge Digitally enhanced products New business models Digital channels	Internal and external collaboration
Operations dimension	Product innovation practices Appropriation Dynamic capabilities' growth effect on outcome and performance	Digital platform infrastructures Bimodal IT structures Institutionalized innovation processes
People and skills dimension	Ensuring digital readiness Growth of IT capacity Development of dynamic capabilities Effect on outcome and performance	Individual creativity and innovation capabilities ICT literacy
Cultural dimension	Organizational support culture Engagement of managers and employees Product innovation practices Appropriation	Innovative organizational culture
Governance dimension	Regulation Engagement of managers and employees	Strategic embeddedness
Technology dimension	Ensuring digital readiness IT capacity growth Development of dynamic capabilities Development of a digital strategy Business alignment Reformed IT areas	Digital platform infrastructures Bimodal IT structures

The original model that is being proposed is depicted in Figure 2. It is also possible to see the aspects that compose each intersection, providing more detailed information of the nature of each cell in the model grid. All aspects can be seen as appropriate to measure on a scale and to provide detailed descriptions in a rubric-like maturity level description.

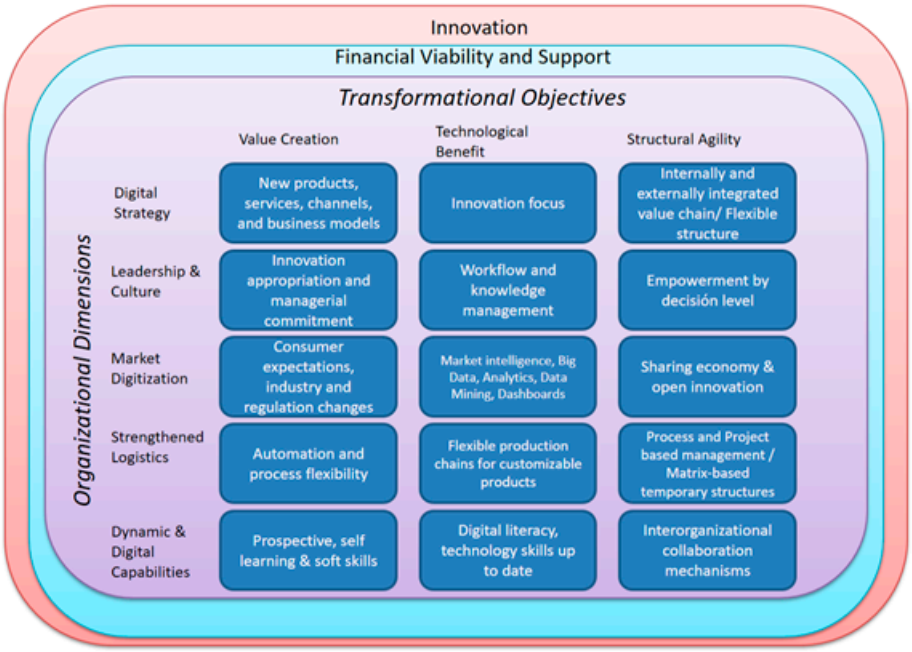

Figure 2. Multidimensional integrated model of digital transformation.

3.2. Developing and Applying a Measurement Instrument

The matrix observed in the model consists of the interactions of five organizational dimensions with three transformational objectives. The ICT infrastructure is specifically denoted in the second column, although it is not considered a unique objective. Rather, it is an enabler of value creation and structural agility for the organization. An instrument was then developed to measure each one of these intersections, as well as those between the transformational objectives and the two cross-sectional dimensions: innovation and financial viability.

A five-point Likert scale was used to provide at least three items to measure each intersection in the model and the corresponding cross-sectional variables. Demographic questions were added to provide some richness of context for a total of 80 questions. Three questions were designed with reversed coding for control.

Once the instrument was built, it was evaluated for face and content validity by a panel of participating researchers from different countries. Most observations led to changes to provide neutral language terms so that it could be applied in different countries without further validation. The original language of the instrument was Spanish, and it was intended to be applied in at least five Latin American countries. After the changes were made, a final validation was performed in virtual panels before its application to a pilot study.

The instrument was then applied to 30 organizations of different activities and sizes and distributed in 7 different countries. Convenience sampling was performed, based on the contacts that the members of the research group had in their own countries. After the data were collected, a reliability analysis using Cronbach's alpha was performed. Four elements presented problems, three had low values, and another had a negative value. One could be easily corrected by eliminating a conflicting item. The others, however, were rebuilt, and more items were added for each element in question.

A second pilot of 37 different organizations in 8 countries was undertaken, and reliability analysis was then repeated for the new measures. The Cronbach's alpha indices were above 0.74, and in most cases, they were around 0.9. The final instrument consisted of 85 items.

As part of a larger study, the instrument was applied to organizations in 11 different countries, obtaining a total of 320 responses. However, only 182 had complete answers and were usable. The sample was comprised of organizations in four different industry

categories: commerce (22), education (18), manufacturing (17), and services (125). The latter varied from financial and ICT services to health and public services. The distribution of the organizations in the sample is depicted in Figure 3.

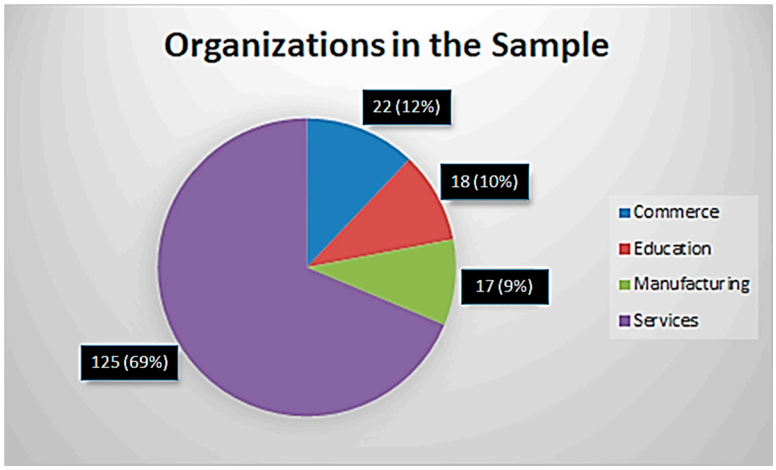

Figure 3. Sample composition and distribution (frequency and percentage).

3.3. Identification of Contextual Considerations for Universities

Scores for each organizational dimension, cross-sectional component, and transformational objective were calculated by industry. This was done to get a general perspective of the state of digital transformation in each industry and particularly to benchmark higher education with respect to other industries.

First, the analysis results of the aggregated scores for the transformational objective were calculated as shown in Figure 4.

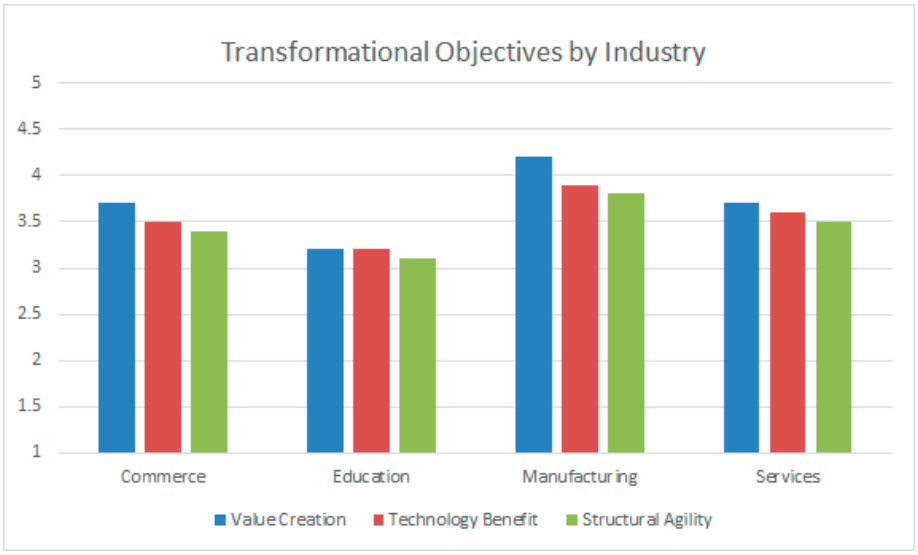

Figure 4. Transformational objective analysis.

It can be observed from Figure 4 that manufacturing seemed to be the leading industry for all transformational objectives. This is surprising considering what was exposed in the literature review [12], where heavy hardware-dependent industries were supposed to be more limited in terms of digital transformation capabilities, as opposed to light industries like education. This leads to the belief that there is leverage potential in all industries, but the application is done differently, depending on the nature of each. Thus, while logistics in the manufacturing industry may benefit from robotics and machine learning as well

as autonomous vehicles, it translates into electronic delivery systems, repositories, and collaboration platforms for education. Nonetheless, considering that the desired value of maturity is five, and it can be expected that there is a certain level of score inflation due to self-reporting issues, there is still a considerable way to go. Structural agility seemed to be the weakest point in all industries, making it evident that innovation efforts and technology investment efforts were not necessarily accompanied by changes in the chain of command that allowed for more flexible structures and true empowerment at all organizational levels.

Value creation, on the other hand, held the highest scores across all industries, allowing us to think that all organizations are immersed to a certain degree in the trends that Industry 4.0 brings along, and they are looking for innovative ways to produce and deliver their products and services with different levels of success. In this objective, the difference between the manufacturing and education sectors reached one whole unit in the scale. For some reason, universities are not grasping the importance of reinventing the learning models and the educational offer to better serve new generations in dynamic times. Nonetheless, the COVID-19 pandemic has probably given them a quick lesson about relevance in that regard.

Figure 5 shows a gap analysis graph for the scores of the transformational objectives obtained for the education sector. Even though it is clear that the scores for value creation and technology benefit were low, structural agility seemed to be a greater problem. This could be due to the traditional hierarchies that universities have, where a clear promotion path is set for professors and the chain of command seems to be quite standard. It is common, however, to find two alternative structures. One is based on colleges and schools, where certain majors are served and all classes are provided with internal human resources, regardless of the knowledge domain. Another option, which is less frequently found yet somewhat common, is the university-wide departmental structure. In this option, faculty members are grouped together in a department for a certain knowledge domain that serves the entire university. Thus, it is common to find mathematics classes taught to business, medicine, or engineering students by professors that are in the same organizational unit. This structure is less common, but it could be considered more flexible to changes and more robust in composition. Structural agility is clearly not an easy objective to attain in an organization with a deeply rooted traditional culture.

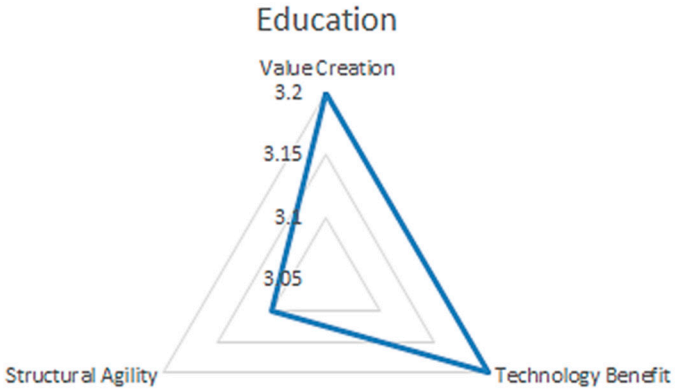

Figure 5. Transformational objective gap analysis for education.

The score for value creation can still be low, based on the common perception by many faculty members, administrators, and even some students that the traditional educational offer is always better. Neither medium technical exits to the curricula nor a more flexible option for personalized curriculum building are planned.

Finally, the technology benefit score may vary significantly from a private school to a public school, depending greatly on funding and strategic alliances with vendors. However, this factor spans beyond establishing an appropriate computer and network infrastructure; it also reflects the ability of the university to successfully apply ICT to enable learning models and foster collaboration and administrative integration of academic activities.

An example of these would be a real integration between the control systems from the registrar's office and the learning management systems (LMSs) where the courses reside and the grades and activities are being recorded and kept. This would be analog to flexible production systems for the manufacturing industry and online sales and distribution for organizations in the commerce industry.

The scores calculated for the organizational dimensions of each industry are shown in Figure 6.

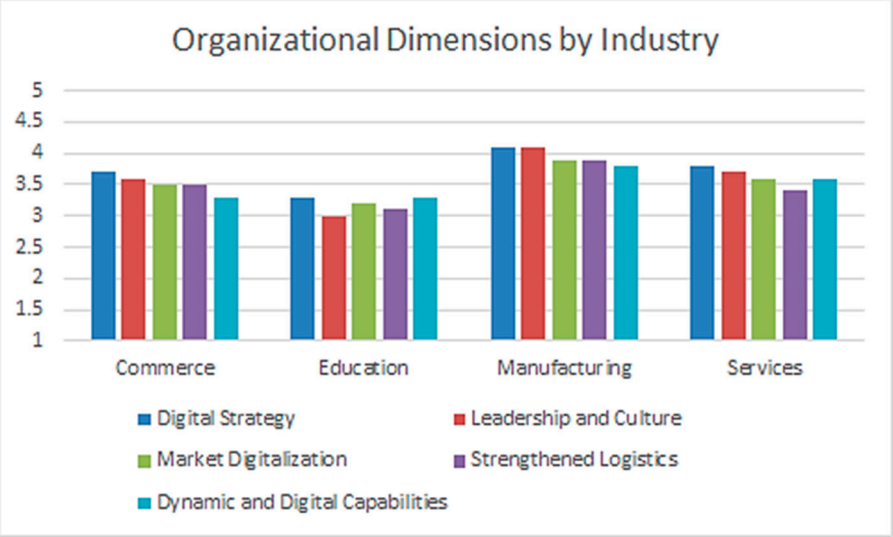

Figure 6. Organizational dimension gap analysis for education.

Once again, education appears to be the industry with the lowest scores for digital transformation, this time from the perspective of the organizational dimensions. Manufacturing stayed in the lead, followed closely by commerce and services. Unlike the other sectors, the lowest score for education was the one referring to leadership and culture. This is interpreted as having strict chains of command, high bureaucracy, and little empowerment at all levels. Apparently, the cultural components of academia tend to resist change and allow for little or no initiative regarding organizational decisions. This is surprising, considering that universities are centers for free thoughts and reflection, questioning, and knowledge creation. It is possible to believe that this applies especially within the purely academic practice, but not to innovation in business processes and practices. This incapacity for enabling suitable leadership and culture may be the inhibitor for the development of the other dimensions. Dynamic and digital capabilities had a score that was equivalent to that of the commerce organizations, meaning that the capacity for environmental intelligence, collaboration, and flexibility was there and it may have been dormant to a certain degree.

The cross-sectional variables, innovation, and financial viability also seemed to be restricted, as shown in Figure 7. It can be clearly observed that the values for both components were the smallest across the industries.

While there seemed to be a well-identified digital strategy in most cases, this was probably of limited scope regarding what the universities wanted to achieve by means of ICT adoption and implementation. It is likely that there is a vision strongly based on providing infrastructure but lacking the intention to apply ICT to enable new educational models and delivery means. Blended learning environments tend to be scarce and are normally optional for faculty members to adopt. However, it is possible that market digitalization is putting pressure on institutions to embrace educational and technological approaches more aligned with the trends of the Fourth Industrial Revolution. Leadership constraints, along with the lack of sufficient funding and innovation promotion, seem to be holding back the digital transformation of universities. The COVID-19 pandemic might

be affecting the perspectives and needs of universities to move forward and successfully transform to embrace digital opportunities, making a leap forward in time that is probably equivalent to the progress that could have been gained in five to ten years in only one.

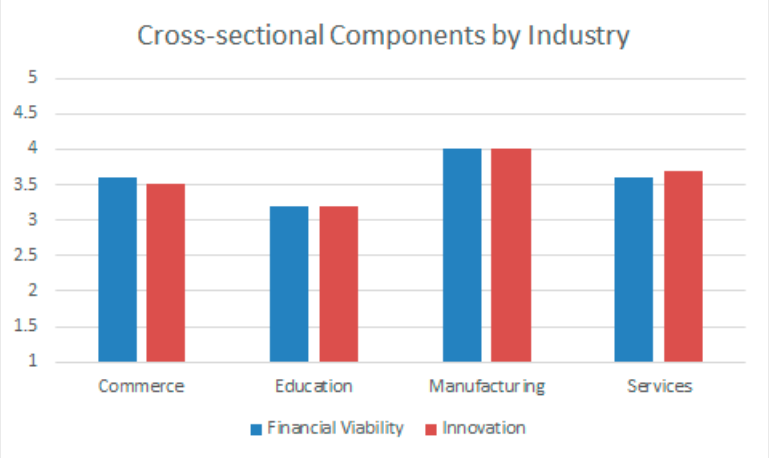

Figure 7. Innovation and financial viability scores by industry.

To better observe the statuses of the organizational dimensions and the cross-sectional components in the education industry, a gap analysis is presented in Figure 8.

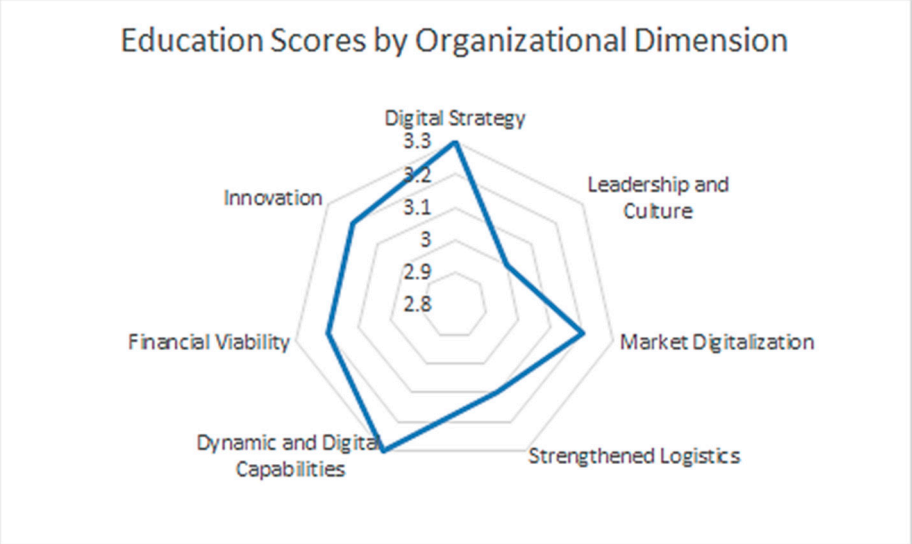

Figure 8. Organizational dimensions and cross-sectional variables gap analysis for education.

4. Conclusions

Digital transformation is a phenomenon that, although it is not new, has gained relevance in recent years as a result of the rapid evolution of technology and the massive spread of telecommunication networks. Hyperconnectivity, artificial intelligence, the Internet of things, block chain, 3D printing, cybersecurity, big data and cyber-physical systems have enabled new practices and business models, changing the way people and businesses interact. Thus, members of the new generations, born and raised in a fully digital environment, are characterized by different needs and viewpoints never before observed. Every common citizen takes on many roles, such as content producers, service providers, social influencers, and many others. Sharing economy mechanisms and social networks allows for unprecedented interactions among people.

Education is no exception. New generations demand different delivery methods and curricular content. Flexibility and personalized offerings have become a common denominator in all sectors, and it is expected that universities will follow suit. However, the traditional practices and views of faculty members and administrators prevent change from happening, requiring students to adapt to a pre-established educational system that no longer responds to today's needs and characteristics.

Providing a mechanism to assess the state of digital transformation and suggest the steps to follow to evolve in the transformation model is paramount for any organization. Many efforts and models have been proposed since the advent of computers in the non-military world to aid in guaranteeing profit from the use of information technology in everyday operations. Nonetheless, this aspect has not been so fully pursued for the educational sector.

Our proposal integrates the main aspects that comprise digital transformation in organizations from many models in the literature. We add value by providing the means to measure the level of digital transformation maturity as well as identify the elements that need to be addressed to evolve and improve the process. Additionally, the elements can be customized to particular contexts, in terms of of industry, size, or other environmental differences to better suit the needs of the organizations under assessment. Finally, the initial diagnostic is made of higher education institutions, clearly showing that they fall behind other sectors, notwithstanding the need to transform and conform to the needs of the digital era.

The approach used in this paper places universities as organizations of any other industries, with organizational structures, dynamic markets, human resources and talent management, culture, processes, and the rest of the elements of a value chain. Nevertheless, nuances need to be identified and considered in the application of a digital transformation effort not only to successfully provide automation, but to strengthen the teaching and learning process, grow the variety of products and services, and promote collaboration and integration. These particularities can vary greatly depending on contextual factors like location, size, university vocation, educational model and vocation, and technology access level. Public universities in developing nations, for instance, are likely to face particular challenges like limited infrastructure and digital illiteracy by the faculty and students among many others. Nonetheless, the elements that comprise the model can be customized to meet specific needs without ignoring the nature of each dimension. The application of criteria based on the knowledge of the context is paramount for success.

It has been observed that higher-education institutions lag behind other types of organizations in taking positive actions toward digital transformation. It is possible that other industries have been forced to move faster as a consequence of market pressure. Nonetheless, the educational sector is beginning to include many alternatives for learning that may appeal more to newer generations. If universities lack the ability to foresee these changes and newcomers, it is possible that they will suffer once they decide to act, being restricted by their own practices, rigid structures, and bureaucratic processes.

The results presented here suggest not only that the educational sector is falling behind others, but also that its main problem may be inadequate leadership practices and a culture against change. This is consistent with the fact that jobs in academia are generally considered some of the most secure. If change can damage job security, it is likely that there will be resistance to it. This is aggravated by planning for digitalization neither in very innovative ways nor with the necessary financial resources for executing plans.

However, there are some limitations that need to be pointed out. First, the sample used was clearly limited, thus making it reasonable to be cautious about the results. Second, the sample only included higher-education institutions, so no claims could be made about other educational levels. In addition, no information was captured about potentially influential factors like sources of funding, university size and vocation, and quality and prestige.

The knowledge obtained from this study only sets the groundwork for further exploration. The sample should be enlarged, and more details need to be recorded regarding

the nature of the organizations in the study. It is suggested to conduct interviews and direct observations to verify the data provided by the respondents, therefore avoiding measurement errors due to misinterpretations or self-reporting issues.

Finally, triangulation is needed to confirm the relationships of the constructs in the model through quantitative techniques. In future studies, a composite index of digital transformation can be developed, and a diagnostic and prediction model can be derived from the existing conceptual framework. From those models, it would be easy to establish consulting methodologies that, when applied to many universities, may provide valuable information to lead along a road toward successful digital transformation.

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