A Roadmap for Digital Transformation of Latin American Universities

Sandra Martínez-Pérez and Guillermo Rodríguez-Abitia

Abstract The year 2020 has made it very clear for universities that they need to transform and leverage information and communications technologies (ICTs) more than ever. Disruptive technologies have gained relevance in every aspect of life, altering the traditional ways for work, family and school environments. Thus, Society 5.0, understood somewhat as the humanised focus of Industry 4.0 developments, provides educational institutions with great new opportunities for innovation, as well as pertinence and quality assurance for their teaching and learning processes. This paper describes a comparative analysis on the use of ICTs for education and administrative processes by higher education institutions in five Latin American countries: Argentina, Brazil, Chile, Mexico and Peru. Their levels of readiness to profit from ICTs are diagnosed, as a function of several factors, including technology infrastructure planning and development, digital skills, educational technology planning, and administrative support, among others. The results allow for undertaking a gap analysis, and a roadmap to overcome the challenges for a successful digital transformation process is then laid out, as well as general recommendations for its use. Insights obtained from this study show clearly that many realities exist, not only between countries, but also within. The lack of infrastructure and financial resources represents major deterrents for ICT appropriation, but it is ICT, in fact, the potential solution for reducing digital exclusion.

Keywords Digital transformation · Higher education · Latin America · Comparative study · Education technology

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1 Introduction

Socio-educational, political, economic and technological changes are influencing people's lives, homes, jobs and education. The rapid technological transformations, leading to Society 5.0, point to four key elements to help the system face the new challenges: education, research, innovation and leadership (UNESCO, 2016). In turn, these transformations: offer new ways of relating and communicating; impact and lead to the construction of digital identities; provide new opportunities for innovation and improvement of the quality of health and education systems; provide a diversity of tools for solving problems and making decisions; give the possibility of generating new jobs or reinventing oneself; and acquire skills aligned with current demands and purposes, among others. But they can also unbalance and highlight their limitations, difficulties and lack of work–life balance, encourage their abusive use and generate new social and digital divides as evidenced by COVID-19 (OECD, 2019a, 2020).

The disruption of technologies in organisations points to the need for a digital transformation that leads to new challenges, contributes to their governance and functioning, strengthens their social relationship, responds to the demands of the moment, and promotes digital policies and agendas linked to society in general, and to education systems in particular (Baker, 2014; Ithurburu, 2019).

Events happening in the year 2020 have highlighted the importance of investing in technologies, and implementing policies and practices lead to innovation and redesign of National Development Plans (NDP) and education plans to be in line with the digital strategies and agendas of Latin American countries (OECD et al., 2020).

Throughout this process, universities have played and will continue to play an important role, not only in the promotion of knowledge, the acquisition of skills and the development of innovation, but also in the digital transformation. Higher education institutions, the Universities 4.0, have to commit themselves and connect with their diverse ecosystems (Barnett, 2017), reinventing themselves to respond to the new economies, trends, demands and commitments of a globalised society (Dewar, 2017).

Under this scenario, our objective is to describe, analyse and compare the use of technologies and academic administration processes in higher education institutions in five Latin American countries, in order to shed light on the different factors that influence the choice, availability and use of technologies, identifying where they stand and drawing a roadmap to reach education 5.0.

2 Digital Transformation: From the Industrial Revolution to Society 5.0

Technological advances (artificial intelligence, robotics, extended reality, the Internet of things, cloud computing, open educational resources, etc.) are transforming the

various contexts (family, social, political, economic and educational) and scenarios (growth, limitation, collapse and transformation) through which we move and prepare for a fast-approaching scenario (Brown et al., 2020). Focusing on transformation, such scenario implies a wide range of innovations resulting from digitisation (conversion of analogue data and processes into a machine-readable format) and digitalisation (use and interconnection of digital technologies and data that lead to changes or creation of new activities) (OECD, 2019a) which leads us to rethink public policies, strategies and practices in different countries. Also, this allows reflecting on the importance and influence of Industry 4.0, consisting of hyperconnectivity and cyber-physical systems that impact organisations and society (Roblek et al., 2016).

The transformation designed by the United Nations (UNESCO, 2016) implies a change in the paradigm of sustainable development in a new industrial era driven, in turn, by a digital revolution (OECD, 2020). The new intelligent society is characterised by a change in the relationships between citizens, by extensive digitalisation and the use of emerging technologies in order to improve productivity, favour teaching and learning processes, increase quality in work, education and health, promote digital skills and make society more sustainable (Garbellano, 2018; Keidanren, 2018; Rodic, 2017). Thus, the digital transformation invites the use of digital technologies through a process of organisational and cultural change (Almaraz et al., 2016; Baker, 2014).

Under this perspective, higher education institutions focus their efforts on social, organisational and technological aspects to carry out this digital transformation. Benavides et al. (2020) present a complex radar of dimensions of the digital transformation which impacts on universities: teaching, infrastructure, curriculum, administration, research, business processes, human resources, extension, digital transformation governance, information and marketing, which in turn combine with a diversity of actors and methods always in accordance with the three aspects mentioned above: social, technological and organisational. For their part, Rodríguez-Abitia, Martínez-Pérez, Ramírez-Montoya and López-Caudana (2020) identify three essential axes: the technological, the pedagogical and the organisational, which in turn are related to different ways of conceiving technologies: (a) technological one with information and communication technologies (ICT); (b) pedagogical one linked to learning and knowledge technologies (LKT); and (c) organisational one with organisational and collaborative management technologies (OCT). The intersection of the three axes with their respective perspectives provides a new way of visualising the use of technologies under an approach of empowerment and participation (EPT), which allows us to face complex life situations and to develop competences that help us to successfully manage all the challenges that are posed by the new Society 5.0 (OECD, 2019c). Such society that is understood as driven by data, being super-smart and focused on individual needs and capabilities (Mavrodieva & Shaw, 2020). This is a hyperconnected society that requires social change, freeing itself from the underlying problems of Society 4.0, the information society, which is the result of the fourth industrial revolution. Society 5.0 seeks to transform organisations into super-intelligent institutions by means of information and communication tools and technologies (Schwab,

2017), and it opens up new questions, based on automation, dematerialisation, digitalisation, industrialisation and servitude (Salgues, 2018) that modify people's habits, and the economic and political patterns of the system. It also has a radical impact on the nature of an entity, adopting four levels of digital transformation: the productive process, the action model, the domain and the cultural/organisational (Dutta & Lanvin, 2020).

2.1 The Digital Transformation in Latin America

There is no doubt that the digital transformation brings new challenges and improves the functioning of institutions (OECD, 2019b). For this to happen, society as such must acquire skills in line with the vertiginous advances we are experiencing. In this process of change, universities take on a relevant role in the training of digital competences to draw up new scenarios and educational paradigms in relation to current needs (López et al., 2020).

The CEPAL (2018) focuses on the need for strengthening and renewing digital strategies as a part of the digital agenda for Latin America and the Caribbean (LAC) to favour regional collaboration and incorporate and reinforce the use ICT in education, promoting teacher training, innovation in pedagogical models, and the creation of open educational resources, among other actions.

This agenda, linked to the National Development Plans, is a reference for the progress of digital policies, in order to promote the desired transformation, cooperation and integration of technologies in all LAC member countries (CEPAL, 2018; Ithurburu, 2019).

Along these lines, the OECD (2019b, 2019c) and the OECD et al. (2020) draw up a roadmap for the mediation of the digital transformation (Table 1):

In order to chart this route, it is important to be in line with the Network Readiness Index model—NRI—(Dutta & Lanvin, 2020) supported by four pillars: technology, people, governance and impact, which in turn underlies other subpillars (Fig. 1), in order to digitally transform society, and therefore, higher education institutions.

3 Method

As a result of the literature and reference cases review, we identified the main elements that comprise and define the successful application of ICT, LKT and OCT in higher education institutions, and an observation guide was created accordingly. Visits were requested and scheduled for nine universities in five different countries in Latin America.

Table 1 Roadmap for the digital transformation

Dimension	Action
Equip governments with better data and indicators for dealing with the challenges	A1. Make the digital economy visible in economic statistics A2. Understand the economic impacts of digital transformation A3. Encourage measurement of the digital transformation's impacts on social goals and people's well-being A4. Design new and interdisciplinary approaches to data collection
Areas for priority attention	A5. Monitor technologies underpinning the digital transformation, notably the Internet of things, AI and blockchain A6. Improve the measurement of data and data flows A7. Define and measure skills needs for the digital transformation A8. Measure trust in online environments A9. Establish an impact assessment framework for digital governments

Source OECD (2019b) and OECD et al. (2020)

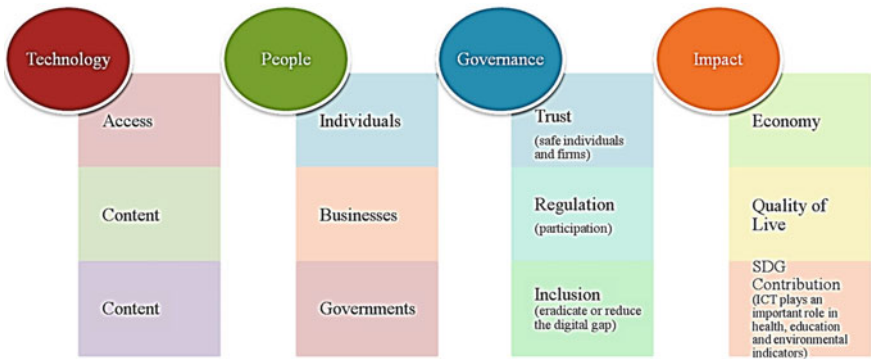

Fig. 1 NRI for digital transformation (Dutta & Lanvin, 2020)

3.1 Sample of Universities

It was sought to reflect a variety of realities that are commonly found in the region, so they were selected strategically based on size, funding source, vocation and location. First, sizes were classified based on the official categorisation from the Ministry of Education of Mexico (SEP-DGPPEE, 2018) mainly as a reference. This categorisation includes four types, according to student enrolment: (1) mega universities with more than 50 thousand students; (2) large universities whose student population

Table 2 Universities in the sample

Institution code	Location	Size	Funding	Vocation
AR-PU-MG	La Plata, Argentina	Mega	Public	General
AR-PU-SM	Buenos Aires, Argentina	Small	Public	Specialised
BR-PU-MG	São Paulo, Brazil	Mega	Public	General
BR-PR-LG	Lapa, Brazil	Large	Private	General
CL-PU-LG	Concepción, Chile	Large	Public	General
CL-PR-LG	Antofagasta, Chile	Large	Private	General
MX-PU-MG	Guadalajara, Mexico	Mega	Public	General
MX-PR-LG	Guadalajara, Mexico	Large	Private	General
PE-PR-ME	Lima, Peru	Medium	Private	Specialised

ranges between 10 and 50 thousand; (3) medium universities with between 5 and 10 thousand students; and (4) small universities with a student body smaller than 5 thousand in total.

Additionally, the selection included also both public and private universities, understanding that they face very different conditions in Latin America, due to the great dependence that public universities have on assigned budget, and the private ones on enrolment to have financial income to operate.

Another important classification item was vocation, distinguishing between universities that offer a wide spectrum of majors, as opposed to those that specialise in a particular discipline, such as business or education.

Finally, all universities were located in countries that constitute leading economies in the region, so that fare comparisons could be made to those in fully developed nations. The distribution of the universities in the study is detailed in Table 2. The names of the universities have been removed for privacy purposes. Names have been replaced with codes that include two characters that identify the country where they are located (AR for Argentina, BR for Brazil, CL for Chile, MX for Mexico and PE for Peru), followed by two characters that indicate the source of funding (PU for public and PR for private) and two characters that refer to size (MG for mega, LG for large, ME for medium and SM for small).

3.2 Field Observations and Visits

Visits were arranged with the authorities of the sample universities, and they were planned to include in-depth interviews with people in at least three key functions: the person responsible for ICT infrastructure provision and planning, the person in charge of curricular development and educational model definition, and professors. The visits included direct observations of different facilities that were directly involved in the application of technologies for both administrative and educational delivery, and

support processes. All interviews were recorded, and later codified and interpreted by the research team.

All visits were done face to face, as there were undertaken before the COVID-19 pandemic forced universities to close their facilities. A full day was dedicated to each visit. Follow up e-mails, telephone calls or videoconferencing sessions were used to clarify post-visit doubts that may have emerged during the analysis of the data collected.

The semi-structured interview guides included twenty-nine open questions that were classified in five categories: (1) five questions about university political commitment to technology appropriation; (2) five questions on ICT infrastructure; (3) ten questions about faculty digital an informational skills development; (4) five questions of ICT curricular integration and access; and (5) four questions related to ICT-based educational resources use in the teaching and learning process.

3.3 Maturity Level Determination

From the interviews, data was coded based on how the content related to specific elements in a rubric that was created to reflect the level of maturity of a particular institution in each one of the three technological dimensions. Thus, scores were assigned as a result of group discussions by the research team, and decisions were made to determine where each institution was placed in terms of maturity. The levels included in the rubric were five: absent, incipient, medium, integrated and consolidated. Each level was described in detail in the rubric in terms of what elements were expected to be observed for each level and dimension intersection. A summary is described below. As opposed to other maturity models where the lowest value determines the assigned level, decimal points were used to show partial progress within each level. From the rubric, we performed gap analysis for each institution regarding each dimension. Thus, their particular diagnosis could be obtained, and it was easy to determine the steps that they required to increase their digitalisation level in all dimensions. Finally, a general roadmap for digital transformation of higher education institutions was drawn to serve as a reference model for planning and following up of universities in their own processes.

The maturity levels are integrated as described below:

3.3.1 Absent

At this level, there is no ICT plan and no mention of it in the institutional one. There is a lack of a dedicated unit for ICT implementation and support, and only individual independent efforts may be present. There are no computers provided for faculty and students, no Internet connection and no software acquisition program. There are no units or efforts to build digital skills in professors and students. There is no institutional effort to incorporate LKTs in the teaching process, no online courses

and no digital repositories. Digital resources are not being produced in an organised manner. There are no OCTs that promote interaction, collaboration and academic management. There is no specialised software.

3.3.2 Incipient

There is now mention of ICT in the institutional plan, but they do not have a plan of their own. Financial resources are seldom allotted to achieve the goals, or they are insufficient. There is some minimum infrastructure available in some areas, and they are normally dedicated to administrative tasks. There might be some loose computer laboratories in place, but their software might not be all legal. There are some courses offered to faculty members about basic ICTs, geared towards operation and no mention of LKTs. The offer is irregular, and it is based on demand. Software is mostly for personal productivity. There are still no online courses, and some basic ICT courses are offered in some majors. Some software tools for basic managerial tasks are in place. In advanced courses, some specialised software can be found.

3.3.3 Medium

There is mention and resources allocated for ICT projects in the institutional plan. There is now a unit dedicated to ICT support. There are computers and some services available for students. Internet access is sufficient in the main areas, but the coverage is not exhaustive. There is a constant training offer of ICT courses for faculty. Professors have the obligation of getting a certain number of training hours, but the type of courses are their choice. Most majors have a basic computing course, and some have specialised courses. There are learning management systems (LMS) available, but not widely used. There are digital libraries, and specialised software, mainly for majors related to science and technology. There is some degree of digital educational resources, but they are mainly stored in closed course platforms.

3.3.4 Integrated

ICT is included in the institutional plan, and it has a plan of its own. There is an ICT unit that provides support and creates norms. Computers and connectivity are available enough to cover the needs of the community. Software is legal, and there are many agreements with vendors. Courses for faculty are planned based on the existing educational model. Professors are given incentives to take them and apply them to their teaching practice. There is personalised follow-up, and they are encouraged to create educational resources. All majors have ICT courses that are geared towards their disciplinary particularities. All subjects for students include the use of technologies. There are standardised educational platforms, and they are widely used. Digital skills are measured for students and faculty, and plans are established

to develop them. There are institutional mechanisms to develop educational digital resources, and financial stimuli for implementing technological and didactic innovations in the classroom. There are many repositories and libraries. Most classes are supported in LMS, and they are integrated with management systems.

3.3.5 Consolidated

The use of ICT is a pillar for attaining the academic and administrative goals laid out in the institutional plan. ICT infrastructure is present in all university facilities. Connectivity is vast, and there are equipment loan services. Classrooms are also equipped to make the most from the use of LKTs. ICTs are centrally governed. Professors have incorporated technology regularly in their classes, and students have the necessary digital skills to aid in their academic performance. Training is focused on educational innovation and specialised tools. ICTs are used intensively in all courses, according to their disciplinary nature. Technology use is transversal in the curriculum. There is multimodality in the course offering. Digital repositories and libraries are used greatly, as well as LKTs available for each knowledge area. Developing digital educational resources and storing them in open repositories is a widespread and robust practice. There are established mechanisms to provide technological support to professors, and they feel comfortable using them. The administration uses learning analytics, facilitated by integrated technological tools. Students are free to choose the preferred modality, always aligned to the educational model.

3.4 Drafting the Digital Transformation Roadmap

Based on the previous maturity levels, a roadmap of actions for a digital transformation transition process can be laid out, as shown in Fig. 2.

4 Results and Discussion

From the data gathered, it was possible to obtain a general panorama of the status of application and vision of technology for each one of the institutions. Later on, scores were provided based on the rubric that was built for that purpose, to determine where they stand in the digital transformation process. We now present an overview of the nine universities by country. These results by no means represent the overall state of affairs of digital transformation for universities in each country. Instead, our aim is to provide a general overview of the Latin American region, as a whole, particularly in countries with certain level of economic leadership within it.

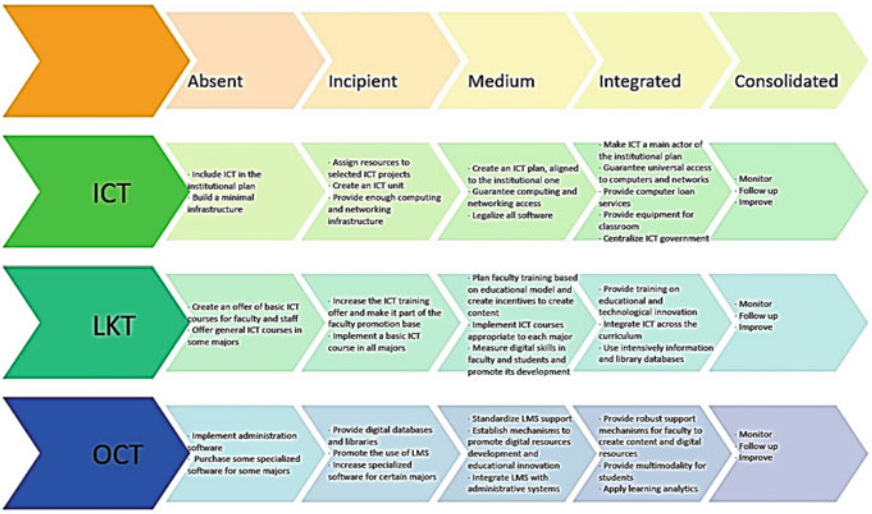

Fig. 2 A roadmap for digital transformation of higher education institutions

4.1 Argentina

The two universities chosen for this South American country are very different in everything but the fact that they are public. One of them is a mega-sized institution with a very wide curricular offer, and a much larger budget than the other, which is small and very specialised in the field of education. The governmental structure of Argentina seems very complex, causing many incentives to be hard to benefit from, in order to build a suitable technology infrastructure. Additionally, the society composition is very polarised, creating great challenges for the institutions to face.

4.1.1 Argentinian Mega-Size Public University (AR-PU-MG)

This university has over 130 thousand students, attending one of more than 100 programs offered. Its development plan mentions the use of ICTs for learning, but this is not made explicit into a particular policy. Support for the use of Moodle as the main LMS is provided, as they prefer the use of open software for ideological reasons. The infrastructure depends on the resources available by each school or faculty independently, so it varies greatly from one to the next. Academic units related to science and engineering are naturals to give higher priority to technology infrastructure than those of humanities and social sciences. This is true both for network connectivity and computing devices.

The area in charge of distance education is also responsible for forming digital skills in faculty members that work in face-to-face programmes. However, this formation is merely volunteer and depends entirely on the demand originated by the professors. They are making efforts to transit to a blended-learning model, not without a great deal of resistance from traditional faculty members. There are virtual spaces and repositories for educational resources. These are validated before publishing. However, there is a great deal of resistance to share resources by the faculty.

4.1.2 Argentinian Small-Size Public University (AR-PU-SM)

This 2-thousand student institution is dedicated to form educators for different levels. It is not strictly considered a university, but it has the same level. Their planning process is not strategically made by the school, but rather at a City and National Government level initiatives, and it includes the appropriation of ICT. However, at times these programs compete with each other, creating barriers for successful implementation, in addition to union-related challenges. Thus, both plans had computer provision programs for students and faculty, leading students to get two different computers, but insufficient Internet access or wireless connectivity available in only a few areas. Also, the curriculum was not designed for the inclusion of technologies yet, despite having some initial work done in that regard.

They have a commercial LMS paid by the federal government. The director promotes the adoption of technologies like Google Classroom but the faculty is not excited about the idea of changing their ways of teaching. Training is provided by the Ministry of Education, particularly on the didactic use of ICTs, with little effect on the actual teaching practice. They lack an effective use of collaboration tools and digital resources repositories, although it is encouraged.

4.2 Brazil

The institutions in Brazil were chosen to reflect two very different scenarios. On the one hand, one of the best ranked universities in Latin America, with a very large student population and very research intensive. On the other hand, a large private institution (not officially consider university by the Brazilian legislation, but recognised as a higher education faculty) that only offers online distance education, and very widely spread all over Brazil, reaching areas that otherwise would not have access to higher education options.

4.2.1 Brazilian Mega-Size Public University (BR-PU-MG)

This university is one of the most prestigious in Brazil and Latin America. It has almost 100 thousand students, a third of which are at the graduate level. Their budget

has been guaranteed by a provision in law that binds a certain percentage of the tax collection to it, so the university is not so vulnerable to government changes in priorities. Some ICT services are centralised, while other depend on each faculty or school. There are laboratories and computer loans in every academic unit. They take advantage of free software tools in cloud computing schemes. They encourage the use of Google and Moodle.

Faculty training varies considerably, and it depends entirely on each academic unit. There is not a program at the institutional level. Professors produce their own content. When there is a special project, professional video production is provided. They believe distance education should be strongly based on classes on videos. They are freely available in the university portal and in YouTube. There are certain administrative systems that are centralised, like payroll and registration. However, there are no specific collaboration tools at a central level.

4.2.2 Brazilian Large-Size Private University (BR-PR-LG)

This educational institution is a private online system that serves over 35 thousand students, and it is distributed in 134 sites, all over Brazil, where students can also do face-to-face activities like exams and final project defences. Their business model is based on local alliances and partnerships. Being almost fully online, technology planning is a fundamental part of their strategy. All sites have computer laboratories and are connected to Internet. Digital educational resources are placed within courses in Moodle, and they are stored both in their data centre and in the cloud. They provide all necessary software to their students.

Faculty training is centralised, and it starts upon hiring. Depending on the degree of the professor, they can become content producers, and they may be in charge of recording classes, in short videos, for the use of the whole academic community. This role will require extra training. Courses are departmental, and they are created with the help of a production team that includes graphic designers and education specialists.

They have an integrated administration system that is also linked to their academic control and delivery systems, as well as an Intranet and a pedagogic system. The communications and information flows are very well designed and supported. They do not use all the LKTs available since their business model does not require it.

4.3 Chile

The two universities included in the study are very similar in size and vocation. They are geographically distant, and one is public and the other one private. They both enjoy a very good reputation and are considered research intensive. The main difference is probably in the economic level of their students, posing specific challenges for the public one.

4.3.1 Chilean Large-Size Private University (CL-PR-LG)

This 12-thousand student university in Northern Chile considers technology appropriation as one of any generic competences that their students need to develop. They have a centre in charge of promoting educational innovation and technological support to the educational process. General productivity software tasks are performed in the students' own devices, and they do not provide computer loans. They, however, have specialised software and laboratories to aid many disciplinary areas with top technology, greatly based on alliances with vendors. Network access and availability is quite satisfactory.

They provide training and mentoring for faculty members to appropriate technology and facilitate the learning and teaching processes, as well as to successfully apply their competence-based curricular design. Nonetheless, this service is completely based on demand, and it is not mandatory for faculty members to engage in this activity. In fact, there are no extra stimuli to do so, therefore limiting their participation. The main base technology for interaction and collaboration is the virtual spaces in an LMS. There are no repositories for digital resources or any other type of community-building support.

4.3.2 Chilean Large-Size Public University (CL-PU-LG)

Just like its private counterpart, this university serves around 12 thousand students. However, these students do not necessarily have their own computing devices or Internet access at home, so they provide laptop loans, and access to computer laboratories, with both general and specialised software. The university does not have an explicit mention of technology in its educational model, although it refers to serving a changing and challenging society. Wireless network access seems to be enough for the needs of the academic community, at least in the main building areas.

There is not a specific organisational area to provide pedagogic and technological support for faculty members to innovate in their teaching tasks. The curriculum includes technology courses, varying greatly to accommodate disciplinary needs. They build their own administrative systems, and they are very well integrated with the academic platforms, including Moodle and G-Suite. They do not have a repository for digital education resources, but collaboration is highly encouraged to produce them.

4.4 Mexico

Both universities in Mexico are in the same city, which is the second largest in the country. It is an area with a reasonably high level of development compared to other regions in the country. Thus, it is expected that they will somehow reflect the highest quartile of the universities in the nation with regard to advancement in the digital

transformation process. Any challenges they face must be greater in less developed areas.

4.4.1 Mexican Mega-Size Public University (MX-PU-MG)

This university is one of the largest in the country, with more than 270 thousand students in different levels. It is also very highly recognised, and it is organised in 15 university centres, depending on discipline or region in the state. ICTs are mentioned in the university's development plan as a means for managing information and learn online. Certain norms and policies are issued and enforced centrally through a university-wide ICT function organisational unit. They provide computing infrastructure through 288 computer centres with more than 60 thousand computers. They, however, lack loan services for devices to be borrowed by the students. Most of the areas are connected to the university network directly, and in few cases, they hire an external carrier. Nonetheless, the bandwidth is insufficient at peak times, due to the large amount of concurrent users that need this service.

There is availability for providing virtual spaces in learning management systems, Moodle being the official one, to those professors who request it. They offer face-to-face and virtual programmes, but they rarely mix. There is a centralised training effort for faculty to build digital skills, foster educational innovation, learn specific LKTs, and discipline-specific technologies.

Finally, there is an integrated academic system. The university provides help to faculty members who wish to develop digital educational resources, and there are well consolidated repositories. There are no specific collaboration systems in place.

4.4.2 Mexican Large-Size Private University (MX-PR-LG)

This 13-thousand student university is very well covered regarding ICT infrastructure. Technology plays a very important role in the strategic plan of the institution, as a means for educational process transformation with a student-centred model. Even though they do not provide device loan services, students use their own, and there is plenty of computers available in laboratories. The use of blended-learning models is widespread, aiming at maturing into the creation of learning communities online.

Faculty training is expected to be self-directed. However, they have a centre for online learning where they can access several courses to improve and innovate the teaching process. The use of technology in class is made in a tacit manner, assuming everyone has digital skills.

For LMS, they use both WebCT and Moodle. There is a continuous collaboration with technology vendors, and they tend to create virtual communities to foster collaboration between faculty and students.

4.5 Peru

For the Peruvian case, we chose a private university, with very good reputation, and specialised in the Business areas. There is no choice of public universities in Peru, and that is a limitation, though it is expected that they will have a performance similar to their counterparts in other countries in the region.

4.5.1 Peruvian Medium-Size Private University (PE-PR-ME)

This university started as a Business Graduate School. Even when it has expanded to offer undergraduate programmes, its main core is still the graduate level. It serves close to 8 thousand students, and it has its main campus in Lima, and some continuing education and extension sites in other cities in Peru.

Computing and telecommunications infrastructure is deemed sufficient, though it can always be improved. The use of virtual technologies is more appropriated for continuing education classes. Graduate programmes professors are more resistant to change, but this is likely changing greatly due to the COVID-19 pandemic. In continuing education, faculty training is constant, and they climb levels of accreditation. There are also workshops and incentives for content creation, though the resources created are rarely shared, but rather used in the classes of the author. Training for traditional courses is not continuous, and it needs to be reinforced.

They use Blackboard and Moodle for different modalities of their education, but they are currently migrating from the former to Zoom. It is estimated that 90% of the interaction between students and faculty occurs with the use of these technologies, and some additional support ones. They combine virtual and face-to-face options, allowing for flexibility in a complex metropolitan environment. All administrative systems are centralised, and they are now implementing an integrated system. All courses are automatically created in Moodle. These are connected to the administrative systems, and much of the resources reside in the cloud.

The results from the different countries and the overall regional gap analysis are depicted in Fig. 3.

5 Conclusion

Transiting towards a successful digital transformation seems to be a straightforward but not easy enterprise. Institutions in Latin America, particularly the public ones, have to strive for an effective technology use to help them provide quality education, while dealing with high uncertainty levels, volatile environments, and complex bureaucratic systems.

The situation observed in all private institutions seems to be quite similar, regardless of the country. This may mainly be because of the high economic level of their

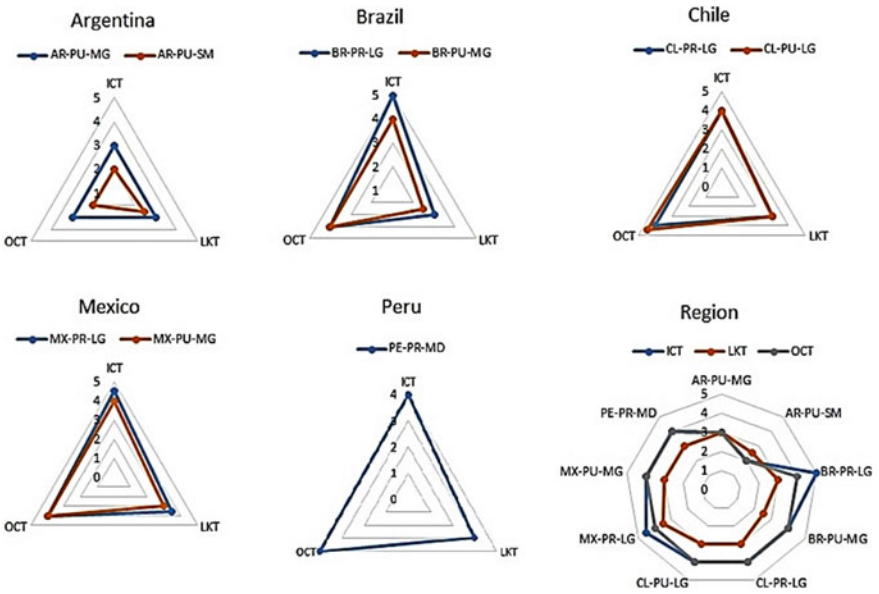

Fig. 3 Gap analysis by country, and overall results

student population, which makes things easier on the institution, not having to worry about digital exclusion circumstances as much as their public counterparts. For them, it is a priority to build a good branding through the effective use of technological resources. In Chile, the difference between public and private institution is not as notorious, provided that they are both eligible for governmental founding.

Mega universities with great budgets are more prone to have a higher level of digital transformation maturity, but they face a great problem for providing full coverage to their extremely large populations.

There is a hint of correlation between the levels of digital transformation maturity of the Latin American universities with the position where their respective countries rank in the NRI. This index shows interesting information about the different factors that affect the quality of education and the ability of these countries to meet the SDG set by UNESCO (2016).

The universities treated in this study are considered, for the most part, to be on the high rank compared to the others in their own nation. Therefore, all aspects reviewed here could be expected to be lower for the overall universe of institutions.

The roadmap for digital transformation proposed can serve as a good starting point to diagnose the current status of an institution and provide the steps that need to be followed to move towards a successful digital maturity level.

Further analysis is in order to include institutions in less-advantaged economies, where inequalities are steeper, and challenges must be greater.

Only through a well-planned innovation and digitalisation strategy, that can overcome severe structural and bureaucratic barriers, institutions in Latin America will

be able to leverage and profit from an intelligent technology use that guides them to provide the quality and pertinent education that the region so desperately needs to foster development.

After this brief X-ray, one of the key ideas emerging from this whole panorama of Latin America in terms of digital transformation is the importance, as dictated by the OECD (2019a, 2019b, 2019c, 2020), of designing and implementing public policies in accordance with good strategic planning and in line with National Development Plans (NDPs) and digital agendas.

Thus, the fourth industrial revolution is taking us to the foundations of Society 5.0. Despite the technological advances in the lives of individuals and societies, and the substantial changes in LAC, there are still major deficiencies related to Internet access, affordability, organisational infrastructures, skills acquisition and digital training. Hence, the importance of carefully and consciously drawing up the roadmap for digital transformation in society and in the universities.

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