ESJ Social Sciences

A Proposed E-learning Technology Management Model for Universities in Response to the COVID-19 Global Crisis

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Doi:10.19044/esj.2022.v18n12p58

Submitted: 06 April 2022
Accepted: 26 April 2022
Published: 30 April 2022

Cite As:
Elnaggar M.E. & Sharaf R.S. (2022). *A Proposed E-learning Technology Management Model for Universities in Response to the COVID-19 Global Crisis.* European Scientific Journal, ESJ, 18 (12), 58. https://doi.org/10.19044/esj.2022.v18n12p58

Abstract

The overall purpose of the study is to propose an e-learning technology management model that responds to the outbreak of the coronavirus disease 2019 (COVID-19) and that has led to the closure of almost all the world's universities in 2020/2021, leading to many complications in arranging for remote teaching and learning processes. The basic design of the study included the analysis of different technology management models in terms of scope and integration. In addition to a survey directed to several international higher education and e-learning experts as well as a thematic analysis for qualitative data obtained from experts' comments and views. The major findings, from both quantitative and qualitative analysis, structured the design of the model that has the advantage of mobilizing all university resources towards the achievement of intended learning outcomes. It focuses on six domains for e-learning technology management: a) planning, b) governance and administration, c) capacity building, d) development, e) interactive teaching and learning, and f) assessment and evaluation. Hence, the proposed e-learning technology management model provides better access, and more economic management of resources, and maximizes return on investment with better learning outcomes at higher education institutions.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Keywords: Technology management, e-learning, higher education, COVID-19, technology infrastructure

Introduction

Most modern Higher Education Institutions (HEIs) face the challenge not only of educating people who represent the human capital needed for the overall development of society but also of generating knowledge that will have a direct impact on society. In this sense, their third mission (in addition to education and scientific research) builds on a meaningful transfer of the results of Research and Development (R&D), providing real solutions to social and industrial problems (Gür et al., 2016). In order for this to occur, HEIs must generate suitable university management processes from within, enabling them to achieve a transfer of technology to support innovation processes (Aceves et al., 2013; Bernardt et al, 2002; Borges & Filion, 2013; Cabrera & Soto, n.d.; Rip, 2011). Therefore, it is essential that appropriate management processes are developed in relation to technologies that emerge within research projects, as part of university management (Díez et al., 2015).

Many universities have taken a new direction in the 21st century with the expansion of globalization, which requires HEIs to redefine their roles, objectives, goals, and functions. They are increasingly expected to act as dynamos of socio-economic growth and political, cultural, social, and technological progress. For this reason, in today's society quality in higher education is measured in terms beyond education itself (Castro et al., 2017, 132).

Similarly, Higher education institutions are increasingly expected to support and monitor the generation, appropriation, and/or adoption of technologies to solve problems identified by society and industry. This can give rise to emerging technologies, meaning technologies in the initial phase of development whose lack of historical data prevent the generation of risk projections and analysis, whose acceptability in the market is unclear, whose ethical challenges are unknown, and whose use is untested. These features of emerging technologies imply a high component of risk and uncertainty (Gavankar et al., 2014). However, emerging technologies are also the most likely to cause major shifts and growth in the market. It is thus a challenge for HEIs not only to identify emerging technologies but also to develop and promote their use. Studies on this issue (Bhattacherjee, 1998; Tegarden et al., 2012) have shown that HEIs which successfully manage emerging technologies evince certain characteristics (Villa, 2015).

Since Higher education regulators demand standards of excellence, therefore the problem under investigation is to design a strategic model of university management as a management tool. It is indisputable that self-

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

evaluation should guide HEI processes and act as an administrative instrument for institutional managers (Castro et al., 2017, 133).

University technology management (UTM) is used for inventorying, monitoring, evaluating, enhancing, optimizing, and securing technology in HEIs (Gaynor, 1999; Jiménez et al., 2007; Tapias G., 2000). Castrejón et al. (2014) argue that the technology management developed in university research groups (UTM) is a triggering element for competitiveness, with various aspects of UTM considered in innovation systems and supported holistically (time, resources, processes, and proper management from all areas of the university) to strengthen and enhance results. University technology management is strengthened through university-industry-society collaboration and, in addition, when higher education institutions (HEI) focus on their "third mission", namely their direct role in economic development and their impact on society (Arvanitis & Villavicencio, 1994; Friedman & Silberman, 2003; Howland et al., 2007; E. Villa at al., 2015). To achieve that mission, a new model of an entrepreneurial and research-driven university emerges as pillar of the knowledge society. This entails challenges such as: a) impelling the development of society as a product of social and economic progress, which is achieved through the effective application of knowledge; and b) showing that higher education can support processes of creation, dissemination and appropriation of knowledge. HEIs that do not embrace these challenges risk being left behind (Díez et al., 2015; Pineda, 2013). To succeed in this new paradigm, universities rely on technology management processes, specifically from university research groups (Geisler, 1995; Mowery & Shane, 2002; Siegel et al., 2003; Silva & Nuño, 2014).

Hence, according to a key study by Syryamkin and Syryamkina, “technology management in HEIs involves the following specific components: business strategy in a high-tech enterprise; identifying and evaluation of engineering capacities; transfer and commercialization of new technologies; marketing; intellectual property; legal protection strategies; commercialized scientific research; research planning and management of a high-tech enterprise; economic evaluation of innovative projects; cooperation with regulatory authorities; export control of technologies; international co-operation; and economic and technological security” (Syryamkin & Syryamkina, 2015, 469).

Technology management also involves the following innovative strategic cycle in education and cognitive management: science – innovation – production – competitive products – market – profit – science. The meaning of the cycle is that science leads to innovation, which leads to production, which generates profit, which once again will fund science and continue to produce innovative production. This is the procedure of performing scientific research and competitive products, ensuring the success of a company. Thus,

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there are two key components in this process: innovative technologies and skilled personnel (Zinov, et al., 2010, 576).

Furthermore, technology management entails an audit to assess opportunities for growth, the competitiveness of the technological solutions used, and the overall structure and effectiveness of a company. Technology management also assumes "lifelong education" as the guiding principle of staff training, supporting basic, continuing, formal, non-formal and informal modes of education, and opposing rigid frameworks based on new "non-systemic" educational institutions, such as corporate universities and mobile forms of supplementary education. (Syryamkin & Syryamkina, 2015).

Now, technology has become the main possible solution with the experience of the global COVID-19 pandemic lockdown. Overnight, education institutions (among which are universities) as well as other business and services organisations, are closed. An unprecedent challenge, happening for the first time in history. Nevertheless, to stop education and learning is not an option. Hence, all universities worldwide, were looking for unconventional ways of sustaining their teaching and learning activities in alternative ways. Online education has become the only option. No matter how ready governments are for this option, it was an imposed solution that has revealed the technological gap and divide causing inequalities among socio-economic groups that lack proper access to technological infrastructure and means. No clear policies or strategies was regarded optimal simply because the level of readiness of universities differ from one institution to another. Moreover, The US National Research Council (1987) described technology management as "a process, which includes planning, directing, control and coordination of the development and implementation of technological capabilities to shape and accomplish the strategic and operational objectives of an organization". Technology management is becoming more important for solving problems within organizations.

This had a serious effect on higher education as universities had complete lockdown and closed their campuses. Despite the instant response of higher education institutions to substitute face-to-face sessions with online education, these closures affected learning and examinations as well as the safety and legal status of international students in their host country. Perhaps most importantly, the crisis raises questions about the value offered by a university education which includes networking and social opportunities as well as educational content. To remain relevant, universities will need to reinvent their learning environments so that digitalization expands and complements student-teacher and other relationships (Schleicher, 2020, 4).

On-campus teaching and learning were interrupted by Covid-19 as schools and universities adopted physical distancing measures. In early 2020, UNESCO announced that school closures in a few countries had suspended

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

education activities for millions of students in various locations. Late March 2020, i.e., a few weeks after the World Health Organization had acknowledged the outbreak, national school closures had impacted almost one and a half billion students (UNESCO, 2020).

By the end of July 2020, only a very small number of universities had reopened. Soon after, most schools and universities around the world suspended in-person instruction, and many of them adopted alternative modalities of education delivery, including using online learning and relying on radio, television, mobile applications, and printed materials (Reimers & Marmolejo, 2022, 5).

Some of these alternative education arrangements represented innovative uses of existing technologies, which were the result of novel forms of collaboration and partnership among various kinds of organizations, including collaborations between schools and school systems and universities (Reimers & Schleicher, 2020).

The resulting limited options available to learn during the pandemic led to a growing concern over the impact of the pandemic on learning loss, student mental health, student disengagement with learning, and potential dropout, and over the long-term impact of these conditions on students and societies, as well as concern over growing disparities in the opportunity to learn (Reimers & Marmolejo, 2022, 6).

Also, COVID-19 Pandemic have many Educational Challenges, and universities put emergency action plan aimed at transitioning the delivery of courses into a virtual environment for their own students, including Online Delivery of Teaching-Learning, Development, and Deployment of Online Resources, Professional Development, Research, and Supporting Policy and General Outreach. (Al Nuaimi, Zainal, & Marmolejo, 2022, 228-231)

Study problem

As a result of the current coronavirus (COVID-19) crisis worldwide, the importance of e-learning has become clearer than ever. All universities are struggling to apply distance education technology given the fact that most are closed with no physical access whatsoever for students. This has demonstrated the importance of technology management for e-learning. Nowadays, millions of students attend online lectures, work on assignments, and watch on- and offline videos and material related to their courses of study. Only universities with a solid technology management strategy can survive in these difficult times. Hence, the research problem can be expressed in the following question: ***How can a reliable post-pandemic technology management model be designed to meet the distance e-learning education needs of universities worldwide?***

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Study objectives

The objective of this study is to develop an e-learning technology management model for higher education by

1. Identifying basic features of e-learning in higher education;
2. Reviewing models that influence e-learning technology management in universities;
3. Proposing a model for e-learning technology management in higher education;
4. Validating the model through a survey of e-learning and higher education experts.

Literature review

The education sector is undergoing a major transformation in the digital era. Students across the world are no longer interested in unidirectional 'chalk and board' teaching methods as they desire the learning process to be integrated and upgraded (Kupriyanova, et al., 2014). Online tools (i.e. e-learning) provide an opportunity for HEIs to facilitate, simplify, and contextualize the entire process of learning. Mohammadi (2015) argues that e-learning offers better access to a global student body without geographical limitations. All students can access courses from renowned institutions like Oxford and Harvard without any proximity requirement. Al-Qahtani and Higgins (2013) argue for the scalability benefit of e-learning, claiming that it benefits HEIs by saving a great deal of cost and time and letting them focus on better-quality delivery of knowledge. Cole et al. (2014) estimate that the effective utilization of an e-learning system has the potential to increase the information retention rate of students by 25–60%. Frehywot et al. (2013) point to other benefits of e-learning systems for both students and institutes, including personalization, quick lesson delivery, instant upskilling, and improved pace.

Hence was the need for technology management models to regulate the use of technology for education-related activities within and beyond higher education institutions. In this regard, Alshaher (2013) provides a technology management model for e-learning systems based on McKinsey's 7S Model, which includes the dimensions of Strategy, Structure, Systems, Style, Staff, Skills, and Shared Values. Alshaher argues that the multidimensional model ensures the readiness of the e-learning system and recommends that teaching institutions use the same model because it delivers a single composite score. If all the items in the model are postulated as a single first-order construct, then the mode will create ambiguity in ensuring the contribution of a specific element towards the overall construct. Researchers found that this model does not comprehensively support some of the teaching and learning requirements, particularly with regard to interactivity and students' active role in learning in

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addition to being a rather inward model that did not take into consideration the external factors (like technology infrastructure and students access to internet off campus) and role of stakeholders into the e-learning process including employers and community members.

Naumova et al. (2017) provide another descriptive e-learning technological model by which existing techniques of learning are directed towards the reinforcement of electronic boards and other modern technical means. This model focuses on helping students overcome specific problems in their educational activities. He suggests using this model as it allows the student to undertake vigorous cognitive activities by analyzing current situations. It is also one of the most widely used teaching methods in the world. Yet, this model also focuses on the management of teaching and learning primarily with disregard for technology tools, skills, stakeholders, infrastructure, and other external factors.

Odii et al. (2013) propose another technological environment for e-learning. This comprises various modes and learning tools, including participation, content, instruction, structure, and evaluation. This model supports the development of detailed learning processes and activities with library support for students engaging in detailed learning through integrated collaboration tools. The interactive tools can be used along with activity tracking aimed at integrating personal diaries and learning events. This model though is more comprehensive but was seen by researchers as teacher-centered in nature where it focuses on the perspective of teaching staff and their needs in terms of delivery of teaching of different teaching and learning activities. It did not include students or other stakeholders' roles in the model as well as external factors that might affect the effectiveness of the model operation, particularly for off-campus teaching and learning activities within distance education mode during the lockdown.

Eraqi et al. (2011) provide an e-learning model for professional organizations, also indicating how it can be customized for use in educational institutes. They claim that the model can be used to raise the employability and academic skills of graduate students. It comprises three levels through which students not only gain the required information but also the desired educational support from tutors. Also, Morales et al. (2018) developed a model of technology and innovation management in higher education that included the factors of Systems Thinking, Globalization Dynamics, Complexity, University, and Risk. They also designed an educational model for universities based on the technology and innovation model which included the factors Internet, Regulations, Multimedia, and Global Networks, Work-based Learning, Integrated Learning, Problem-based Learning, Innovative Environment Learning, Cooperative Learning, Experiential Learning, Blended Learning, and Contextual learning. Another one of the most

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commonly used technology management models is the Six-Facet Model. It includes six main parameters: a) planning, b) implementation, c) training, d) change, e) technology evaluation, and, f) product and process integration. Yet, these models remain to be inward-looking models not considering the specific nature of distance online education and e-learning as well as external factors that are essential for the success of teaching and learning practices that contribute to the educational program competencies and intended learning outcomes.

Due to the growing importance of E-learning for educational institutes in the digital era, particularly after the pandemic, researchers found the need for the development of a comprehensive technology management model that builds on and integrates previous models and adds further requirements that pandemic has exposed for a complete distance education e-learning model. Tas & Yeloglu (2018) described the need in higher education to include several management modules – technology management, knowledge management, and strategic management – in the first or second academic years of undergraduate courses. Ways to make technology programs more effective include examining more case studies about technology management in organizations, inviting more specialists to universities to relate the real-world experience, and giving students real technology management problems to solve. Internships for technology management undergraduates also help them network and form a bridge between university and industry. Such efforts support long-range planning by universities.

Owston et al. (2013) identify five main technological factors that are advised to consider when designing e-learning systems for educational institutes. Mtebe & Raisamo (2014) suggest authoring packages in which the instructors can overcome the difficulties involved with programming languages. Porter et al. (2014) posit that the learning management system must be designed effectively to monitor all learners' performance. Wanner & Palmer (2015) stress the importance of content management systems to deliver learning content to students and to facilitate tracking and data retrieval services. Education institutes must ensure the compatibility, maintainability, modularity, usability, and accessibility of the e-learning system (Kirkwood & Price, 2014). Researchers felt the need for further investigation to examine the validity and effectiveness of the proposed technology management model.

Methodology

Due to the interrelated, dynamic, and interdependent nature of e-learning technology management, researchers applied a system-based approach to develop an e-learning technology management model for higher education institutions. Kaufman (1970) summarizes the system-based approach in two words – analysis and synthesis – where analysis involves

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identifying component parts and determining the relationships among those parts and between the parts and the whole system. Synthesis involves the design of a raw system so that the identified problem can be solved. Mukwa (1979) defines the system-based approach as a process by which needs are identified and solutions are selected from a range of alternatives, methods, and means are obtained and implemented, results are evaluated and revisions to all or part of the system. Hence, we designed the model components with reference to inputs, processes, outputs, and feedback loops.

Besides, thematic analysis was used as the qualitative analytic method for the experts' views and comments about the model.

"Through its theoretical freedom, the thematic analysis provides a flexible and useful research tool, which can potentially provide a rich and detailed, yet complex account of data" (Braun & Clarke, 2006, 5).

An inductive approach was used to identify the basic components and features of the proposed e-learning technology management model based on data provided by the experts. Then, the research followed the six steps of analysis developed by Braun and Clarke (2008)

Model Validation

An analytic questionnaire was designed on the basis of the components of the proposed model.

Though it has not yet proceeded to system operation and evaluation, the proposed model was validated using the designed questionnaire by a group of experts from different institutions and different countries (as shown in Tables 1 &2).

Table 1. Model Validation Experts sorted by affiliation

	Affiliation	number
1	Ministerial level senior staff (Ministry of Higher Education and Ministry of Information & Communication Technology)	6
2	University leaderships (Presidents, Vice presidents & Deans)	10
3	International organizations	5
4	E-learning experts	10

Table 2. Model Validation Experts sorted by country.

	Country	number
1	Costa Rica	1
2	Egypt	14
3	Japan	4
4	Jordan	7
5	Saudi Arabia	2
6	USA	3

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The questionnaire was sent to 100 experts representing e-learning professionals, university experts, and leaders at international universities and IT organizations using an electronic form (Google form), Convenience sampling was used where experts were recruited through professional, alumni and personal networks. They were selected to represent different cultures and levels of administration within universities as well as other sectors that support e-learning provision (ministries, policymakers, IT organizations, etc.) to reflect comprehensive views about the model. We were able to collect feedback from 31 of them (i.e., a response rate of 31%). The experts were asked to estimate the importance level of each domain, dimension, and item of the model by rating each component using a five-level scaled evaluation (Strongly Disagree – Don't Agree – Neutral – Agree – Strongly Agree) graded 1–5. The percentage was calculated for each, item, dimension, domain, and the whole model.

Students' voice was inferred from research conducted on the university, post-pandemic, reflecting their learning experience and needs in relation to technology management within distance and online education. A study about Students' Perceptions of Using Microsoft Teams Application in Online Learning During the Covid-19 Pandemic revealed that 81.2% of students hoped that the learning process would continue online during the pandemic. However, the online learning process needs improvement where the learning process must be packaged as more attractive through various interactive methods. In addition, the interaction between lecturers and students and amongst students must be improved. They also expressed the need for improvement in the method of presenting learning material which is seen as monotonous and boring. The application of attractive learning methods is needed to increase student interest in learning and understanding concepts. Students hope that there will be some tutorial regarding the usage of applications and complained that using online learning requires a lot of internet quota to use in addition to inadequate internet network being unfortunate for students who have economic limitations. (Wea & Kuki, 2021).

The study by Abramov, Tatarnikova, Sikarev, Shilin, & Chusov (2021), has advised integrating virtual reality (VR) technologies, that can reduce the total cost of the learning process independently and with the advice of a teacher. the transition to innovative and digital technologies, the introduction of distance learning into the educational process, and the emergence of new external factors require the educational system to ensure a qualitative transition to new technologies. This requires capacity building to be ready for such changes and to be able to improve the quality of the educational process, gain additional skills and enhance students' competencies. Other studies expressed the importance of an interactive learning environment, reliable infrastructure, sufficient internet quota, and

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guidance through tutorials and technical support were the most evident factors students wish to integrate into the model (A'yun, Suharso, and Kantun, 2021; Alsoud & Harasis, 2021).

On the level of leadership, a global survey was conducted on college and university leadership by the International Association of University Presidents and Santander Universidad on leadership responses to COVID-19 in 2020 which has indicated that the majority of universities consider their institutions not ready for COVID-19, where 58% focused on the need for faculty training and technology needs, 54% on maintaining academic standards, and that the majority of them (73%) are preparing for the blended mode of learning where 83% are considering investing in technology infrastructure. 63% of them are considering virtual mobility and 47% for internationalization at home. This was an insightful contribution to the technology management model design from a leadership perspective.

Results and Discussion:

a) Quantitative analysis

The importance level (%) of the proposed model components was evaluated by the experts using an analytic questionnaire. Findings are summarized in Table (3) and discussed below.

Table 3. The importance level (%) of the proposed model components is evaluated by experts.

No.	Domain	Importance (%)
I.	**Planning**	**88.40**
I.1.	**Program / Course Development**	**91.36**
I.1.1	Program / Course intended learning outcomes	92.59
I.1.2	Program / Course description	93.33
I.1.3	Content development	90.37
I.1.4	Assessment & Evaluation framework	93.33
I.1.5	Assignments and tasks	91.85
I.1.6	Academic calendar for each course every semester	86.67
I.2.	**Program / Course plan for e-learning**	**86.67**
I.2.1	Course storyboards/plan for e-learning	87.41
I.2.2	Multimedia planning	82.96
I.2.3	Digital knowledge resources	89.63
I.3	**Planning human resources**	**87.16**
I.3.1	Human resources needed	85.19
I.3.2	Roles and responsibilities	88.89
I.3.3	Needs assessment for capacity building	87.41

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No.	Domain	Importance (%)
II.	**Governance & Administration**	**86.49**
II.1.	**Decision Making & Taking**	**85.33**
II.1.1	University management system (UMS)	91.85
II.1.2.	Metadata & data management	85.19
II.1.3	Boards decisions documentation	82.96
II.1.4	Archiving system	85.19
II.1.5	Financial management system	81.48
II.2.	**Enrolment management**	**88.40**
II.2.1	Student online payment, registration, and enrolment	88.89
II.2.2	Students and staff logs' monitoring	87.41
II.2.3	Academic advising	88.89
II.3.	**Quality assurance**	**85.74**
II.3.1	QA online surveys to all stakeholders	85.93
II.3.2	External review reports	85.93
II.3.3	QA aggregated data and reports	87.41
II..3.4	Quality progress reports publishing	83.70
III.	**Capacity Building**	**89.28**
III.1	**Resources**	**91.67**
III.1.1	Faculty members	90.37
III.1.2	E-learning development teams (instructional designers, editing teams, graphic designers, etc.)	88.89
III.1.3	IT specialists & technical support	95.56
III.1.4	Hosting: Data centers/cloud hosting	91.85
III.1.5	Applications: e-learning author software & learning management system	89.63
III.1.6	Databases	88.15
III.2	**Skills**	**86.17**
III.2.1	Gap analysis	84.44
III.2.2	Training for different groups	88.15
III.2.3	E-learning research & development	85.93
III.3	**Connectivity**	**90.00**
III.3.1	Connectivity policy	89.63
III.3.2	Connectivity services	89.63
III.3.3	Connectivity maintenance	89.63
III.3.4	Out-of-campus Internet service	91.11
IV.	**Development**	**85.37**
IV.1.	**Development**	**83.70**
IV.1.1	Digital content development	87.41

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No.	Domain	Importance (%)
IV.1.2	Glossary of terms development & integration	82.22
IV.1.3	Objects' scanning & multimedia development	80.00
IV.1.4	Learning resources allocation	85.19
IV.1.5	Virtual learning tools development (virtual labs, galleries & reality)	85.93
IV.2.	**Validation**	87.04
IV.2.1	External review for e-learning	85.19
IV.2.2	Dry run and continuous evaluation	88.89
V.	**Interactive Teaching & Learning**	**89.26**
V.1	**Communication platforms**	**89.26**
V.1.1	Learning management system discussion forums & chat	88.89
V.1.2	Virtual classrooms and files sharing	91.85
V.1.3	Synchronous teaching activities	86.67
V.1.4	Interactive instructional tools (drag and drop, voting, interactive videos, virtual reality and integrated augmented reality tools)	89.63
VI.	**Assessment & Evaluation**	**84.92**
VI.1.	**Online Evaluation**	**87.62**
VI.1.1	Assignments management	92.59
VI.1.2	Online quizzes	88.15
VI.1.3	Participation follow-up	89.63
VI.1.4	Question banks	86.67
VI.1.5	Projects assessment	88.89
VI.1.6	Research	85.19
VI.1.7	Final exams	82.22
VI.2.	**Exit requirements**	**82.22%**
VI.2.1	Program / course ILOs verification	85.19%
VI.2.2	Certification exams preparation	80.74%
VI.2.3	Certification exams	80.74%
Total Percentage		**87.29%**

As shown in table (1), the **"Planning"** domain comes as the third most important domain of the model (88.40%). The importance of the three dimensions of this domain is arranged to descend as follows: "Program/Course Development", "Planning human resources", and "Program/Course plan for e-learning", "**Governance & Administration**" domain comes to the fourth important domain with a level of 86.49%. It includes three dimensions: "Enrolment management", "Quality assurance", and "Decision Making &

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Taking", "**Capacity Building**" domain was the most important one with a level of 89.28%. It consists of three dimensions, the most important of which is "Resources" followed by "Connectivity" followed by "Skills", and "**Development**" was the fifth most important domain of the Model with a level of 85.59%. It consists of two dimensions: "Validation" and "Development", "**Interactive Teaching & Learning**" was the second important domain of the model with a level of 89.26%. It includes only one dimension, "Communication platforms", "**Assessment & Evaluation**" was the sixth most important domain of the model with a level of 84.92%. It consists of two dimensions: "Online Evaluation" and "Exit requirements", and **The Total percentage of the Model Agree is (87.32%) with the Mean (4.366/5)**

b) Qualitative analysis:

Based on the thematic analysis approach used, data were coded where several codes were combined into themes and sub-themes. Codes that did not appear very often in the data were discarded. Comments by experts focused on the requirements and limitations of the model and its components for this model to be feasible.

Based on which, the following themes have been generated:

a) Context

Context was the main concern for experts where awareness of stakeholders (parents, students, employers, local communities) and their active involvement in planning and governance domains is a critical requirement for the successful implementation of the model. The Out-of-campus infrastructure and internet service are other factors determining the operation of the model.

b) Learning approaches

The used learning approaches were seen to be another factor that affects model implementation where for instance student-centered learning (SCL) would have requirements that will differ from the teacher-centered learning approach. Similarly, the competency-based assessment also required extra features and capabilities of online assessment and that needs integration with hands-on real-life skill-based learning objectives. Moreover, the integration of learning theories and policies will reflect on content design and interactivity. For example, the multiple intelligences theory requires the integration of multimedia, text, and interactive content that caters to the visual, logical, kinesthetic, and linguistic learners both in teaching and assessment.

c) Sustainability

Both financial and administrative sustainability was highlighted by experts in comments where they questioned the integration of financial mechanisms throughout the governance domain that looks after sustaining hosting costs, software licenses, and upgrading plans to cope with the

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everchanging nature of technology. In addition, upgrading of staff (academic, technical, and administrative) capabilities with the creation of a pool of young leaders who can work on model sustainable and stable implementation are to be considered.

d) Equity

Considering different students' needs is a requirement for the model operation where consideration of the financial burden students might incur to get access to offline and online learning materials and resources including the size and cost of data transfer required and the discrimination this might entail against students from disadvantaged socio-economic backgrounds or those living in remote areas with limited access to quality internet service. Another equity factor was highlighted in the provision of gender-sensitive content where male/female equal representations might be needed in multimedia used especially in fields of specialisations that are regarded in some communities as a male of female dominant professions (e.g. engineering for males and nursing or teaching for females). Hence, experts questioned whether there would be means where universities can secure alternative ways for ease of platforms access by students in addition to data analysis of the helpdesk and support services offered to students to look for evidence-based equity practices. Also, some gender sensitivity parameters are to be introduced in the design and validation phases of the content development.

e) Quality

Quality of inputs, processes, and outputs that have been identified by the model is of extreme importance as highlighted by experts in all model domains and dimensions. Stress was made on the integration of quality standards in internal review processes that investigates quality indicators of model implementation.

f) External efficiency

Feedback from employers about the quality of graduates as well as research and services is to be taken into account to identify the external efficiency of the model operation. Employers need to be asked if they can feel a difference between graduates' competencies before and after e-learning implementation and whether they suffer from the lack of applied skills and professional attitudes as a direct impact of the distance modes of learning.

Description of the Proposed E-learning Technology Management Model

Since the intended outcome of e-learning as an educational service is the development of students' knowledge, skills, and attitudes, an e-learning technology management model should extend beyond course content and provision to assessment and evaluation processes that verify the achievement of the intended learning objectives (ILOs). And since the proposed model targets the management of the COVID-19 worldwide crisis, it relies on a

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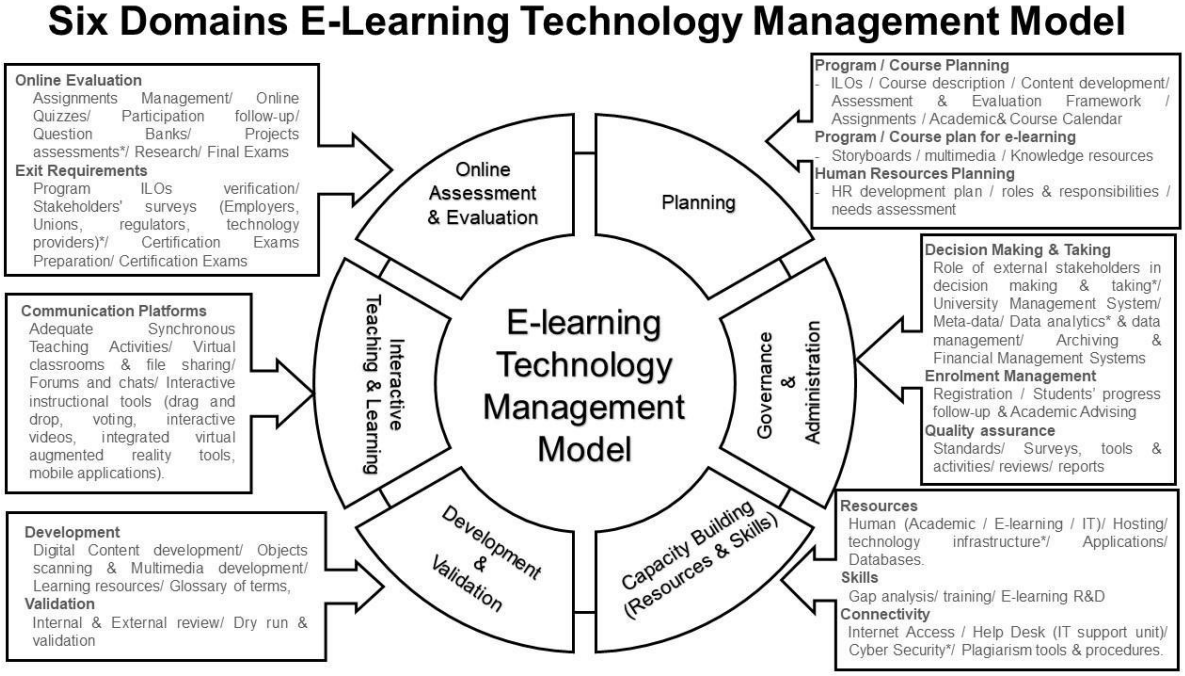
distance learning model with some possibility of face-to-face and direct contact teaching.

The model domains, dimensions, and statements were designed based on the models illustrated in the literature review in addition to the authors' personal experience who used e-learning for more than fifteen years in university teaching and management. Subsequently, some dimensions and items were added or modified, based on the feedback from the experts. Hence, differences between the questionnaire items and the actual model were due to the proposed input from experts. For example, some experts found that the proposed model as identified by the questionnaire elements is an inward-looking model that does not consider the involvement of external stakeholders and employers. Thus, A component was added to the governance and administration domain assigning roles for external stakeholders in the decision-making and taking process. Moreover, experts have dedicated attention to the quality component requesting the involvement of benchmarking and external review processes.

The proposed E-learning Technology Management Model is an integrated model that applies to both blended and distance modes of learning and is composed of six main domains: a) planning, b) governance & administration, c) capacity building, d) development, e) interactive teaching & learning, and f) assessment & evaluation (Figure 1). We will elaborate on each of these domains below.



* Items added by experts to the model's dimensions and statements

Figure 1: A Six Domains e-learning technology management model

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Planning

This domain is concerned with planning for all required e-learning needs at universities. It starts with planning the program and courses, including the core and specialisation requirements, pre-requisites, and academic progression as identified by the institutional policy and educational model. This is followed by publishing basic information about the e-learning syllabus (course description, calendars, assignments, and examinations) in order to set appropriate expectations and help students plan for their studies. It also includes the gap analysis for skills and resources (in terms of numbers and qualifications) to meet the required e-learning objectives.

The use of AI (such as adaptive learning) in some of the learning objectives is also part of the planning domain and considers what e-learning can accomplish as part of planning for pedagogy, or the pedagogical models a university is adopting.

a) Governance & administration

The model here is concerned with all system steering functions that are needed to implement e-learning at university, and that starts with the decision-making processes of governing bodies like boards and councils. Due to the current negative perceptions about the overall quality of distance education institutions (Nicole L. Davis et al., 2019) and online modes of education among employers that have led to lower recognition of e-learning as well as open and distance education credentials, external stakeholders need to take an active role in the decision-making process. Data availability and management is another integral element of the governance of e-learning, providing university leaders with meta-data and data management strategies employed by the university. Data analytics, correlating academics, finance, and other system components are needed for decision-making that relates to services and support for at-risk students. It's equally important to rely on well-integrated technology tools including digital archiving, a university financial management system, student progress follow-up, academic advice, and quality assurance tools. It also includes features that follow up on students' queries and monitor tutors' workload. Provision and management of information is an integral part of e-learning technology management and can support smooth and enlightened e-learning decisions and students' engagement in all sorts of e-learning activities.

b) Capacity building

The domain of capacity building focuses on ensuring adequate human resources to administer and implement e-learning at the university. It also considers the technology infrastructure needed to run different e-learning activities and continuous technology upgrades have given the fast pace of technological change. Skills development and training activities are also an integral part of capacity building and rely extensively on needs assessment

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

processes carried out in the planning domain. Digital literacy is a basic requirement for both staff and students and should be a regularly updated component of capacity building. Connectivity and internet access, inside and outside campus, are other requirements for efficient communication flow between the university and students. Since the best technology in the world installed on a university campus cannot guarantee efficient communication and learn at locations outside campus, continuous connectivity measurements should be used to guide instructional design and the type of technology used for stable, cost-effective, and efficient educational services. An IT help desk must also be available to provide help and support to students and staff inside and outside the campus. Another very important aspect to consider in the capacity building domain is cyber security and the software used to prevent hacking and other cyber security threats. Given the academic nature of e-learning, it's also important to consider anti-plagiarism tools to ensure that practices and deliverables are compatible with academic codes of ethics and core values.

c) Development

The domain of development deals with content development processes and their review and validation to ensure reliable content relevant to the program and courses. This domain is closely connected to the planning phase as it should follow a specific instructional design as laid out in the course description and storyboards. This includes digital content development, object scanning, and multimedia design and development. It also includes the provision of learning resources and a glossary of terms related to each course. Instructional design as recommended by experts is tailored to reflect the nature of e-learning where a student-centred design engages students for more independent and autonomous learning though some teaching strategies like flipped classroom and programmed learning. A validation process follows development through external review from experts in the local market as well as higher education institutions and research centres. The objective of validation is to ensure that content is up to date and complies with international and national standards. The validation process includes a dry run of developed content where feedback from students is used to ensure the readiness of developed content and compatibility with learning objectives.

d) Interactive teaching & learning

Nowadays higher education institutions emphasize student-centered learning approaches that require students to actively participate in certain activities. E-learning must therefore provide the means for interactive teaching and learning using forums for example is an e-learning privilege that encourages communication among students based on the objectives of the instructional design of e-learning. This can be achieved through synchronous teaching activities that give students the opportunity to communicate with

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

teaching staff at a distance. E-learning applications integrate virtual classrooms and file sharing features that can also help in this regard. Moreover, interactive instructional tools like drag-and-drop, voting, interactive videos, virtual reality, and integrated augmented reality help increase students' engagement. It's very important to note here that these learning tools must serve learning objectives. Some faculty members simply use them because they are fascinated by the technology and sometimes lose track of authentic learning. So, it is important to retain a focus on learning optimization through less sophisticated means. Thus, adequate interactivity in terms of quality, time, and quantity should be considered and assessed through student feedback on interactive, live, and synchronous activities.

e) Assessment & evaluation

The assessment and evaluation domain is concerned with verifying the achievement of learning outcomes as specified in the academic program. It deals with assignment management including publishing, uploading, and downloading of assignments' files, review, and feedback, as well as grading for individual assignments and the overall grades allocated to different forms of assignments. It also manages online quizzes and question banks, and students' active participation in group and individual work. Moreover, the assessment domain requires the full features for projects assessments and research work with group division and task distribution of team members. Final exams are an integral component and are attached to program ILOs verification. The model does not analyze the process from an institutional standpoint; thus, it needs to reflect the role of external processes and players (regulators, employers, unions, technology providers, etc.). Consequently, stakeholders' surveys are required to generate dynamic feedback from stakeholders. It should also consider certification exams as an indicator for comparability of university graduates to labor market needs. Thus, preparation services offered for different types of certification exams as well as coordination for certification exams registration and management are important factors that an e-learning model should consider. Links, resources, and tutorials could be offered on the university e-learning portal as well as to online registration services.

Conclusion, implications & recommendations

The aim of the current study was to propose a model for technology management of universities for distance and blended modes of learning. Findings have provided guidance for the considerations that need to be fulfilled in the model elements based on experts' views. It achieves the integration and interrelation between the model domains and components. Thus, results have indicated that poor or partial implementation of some of the

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model components will affect the quality of learning and limit the model operation and deliverables.

Equity was the main parameter that findings have stressed and that universities need to consider while implementing e-learning technology management that allows access to all students regardless of their socio-economic backgrounds. Hence, the model offers flexibility in adapting technology in a way that suits the local infrastructure and services as well as available applications and software. Because the model is outcome-based and requires the verification of learning outcomes, no specific technology (hardware or software) is specified.

The proposed model has a cost-effective design that minimises resources and maximises return on investment (ROI) while achieving the desired goals. It also tries to find numerous alternatives for face-to-face and traditional learning modes to ensure interactivity and students' active engagement. Concern remains regarding the hands-on development of skills in some of the applied fields of study. This needs to be taken into consideration in the assessment and evaluation of online and distance education.

Hence, the proposed e-learning technology management model provides better access, more economic management of resources, and maximizes return on investment with better learning outcomes through the specified six domains, namely: a) planning, b) governance & administration, c) capacity building, d) development, e) interactive teaching & learning, and f) assessment & evaluation.

Further studies yet need to be conducted to assess the scalability and sustainability of the proposed model given the rapid technological developments as well as the evaluation of satisfaction rates among stakeholders upon the adoption of the proposed model.

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