# Technological Aspects of E-Learning Readiness in Higher Education: A Review of the Literature

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## Abstract

E-learning has become one of the most important technologies of the modern era. E-learning is a learning process which aims to create an interactive learning environment based on the use of computers and the internet. Through e-learning, learners can access resources and information from anywhere and at anytime. Many higher education institutions have expressed an interest in implementing e-learning, and e-learning readiness is a critical aspect in achieving successful implementation. Higher education institutions should therefore assess their readiness before initiating an e-learning project. E-learning readiness involves many components of e-learning, including students, lecturers, technology and the environment, which must be ready in order to formulate a coherent and achievable strategy. One of the aspects of e-learning readiness is technological readiness, which plays an important role in implementing an effective and efficient e-learning project. This paper explores the gaps in the knowledge about the technological aspects of e-learning readiness through the conduct of a literature review. In particular, the review focuses on the models that have been developed to assess e-learning readiness.

**Keywords:** E-learning readiness, technological aspects of readiness, assessment, higher education

## 1. Introduction

Information and communication technology has created new opportunities to improve the existing education systems and learning styles, and has helped to develop and innovate new and effective teaching and learning methods (Salem, 2006). It has also helped to develop many modern concepts and tools in the field of education, such as e-learning. E-learning is the use of electronic media, educational technology and information and communication technologies (ICT) in education (Contreras & Shadi, 2015). E-learning involves the application of new technologies, such as the internet, intranet, email and satellite broadcasts, to the learning process (Puteh (2008). E-learning helps to increase the flexibility of the educational process and facilitate communications and interactions between teachers and students. The provision of this service on the internet makes it available and easy to use by most students anytime and anywhere through the use of their personal computers. E-learning plays a prominent role in the field of education but faces a number of challenges that hinder the achievement of its objectives (Najib & Rebhi, 2006).

E-learning has become an increasingly significant element of the pedagogy adopted in higher education institutions (HEIs) (Kituyi & Tusubira, 2013). According to Tarus, Gichoya, & Muumbo (2015), e-learning is an increasingly popular approach to teaching and learning in most institutions of higher learning worldwide. A review of the literature shows that, in order to adopt a successful e-learning system, the HEI should assess its readiness before initiating an e-learning project. A primary reason for the failure to adopt an e-learning system in higher education is the lack of assessment of readiness for e-learning (Hanafizadeh & Ravasan, 2011; Odunaike, Olugbara, & Ojo, 2013).

E-learning readiness can be defined as the assessment of how ready an institution is to adopt and implement e-learning (Bowles, 2004). According to Borotis and Poulymenakou (2004), e-learning readiness is "the mental or physical preparedness of an individual for some e-learning experience or action". E-learning readiness is also defined as "those factors that must be accomplished before e-learning implementation can be regarded as being successful" (Odunaike et al., 2013).

According to Nyoni (2014), e-learning readiness provides the key information that organisations require in order

to develop strategies which can cater for the specific needs of each learning group. (Borotis & Poulymenakou, 2004) pointed out that e-learning readiness helps an instructional designer to design e-learning strategies and experiences comprehensively and helps a lecturer to effectively deliver learning experiences to students. All aspects of e-learning must be "ready" in order to develop a coherent and achievable strategy. Thus, all aspects of e-learning including students, lecturers, technology and the environment must be ready. The readiness of technological aspects also plays an important role in implementing successful e-learning. AbuSneineh and Zairi (2010) stated that access and ease of technology are the most important factors that contribute to the overall effectiveness of an e-learning system. Bridges et al. (Bridges, Juceviciene, Jucevicius, Mclaughlin, & Stankeviciute, 2014) pointed out that the adoption of new technologies in the field of education has enabled access to education to become easy and universal.

Bhuasiri et al. (2012) highlighted technological aspects as an important factor in a successful e-learning system; hence, the readiness of the technological aspects needs to be thoroughly explored in order to analyze the overall e-learning readiness. Holsapple and Lee-Post (2006) explained that, in an e-learning context, online users must use the technology to complete their online tasks in the online learning environment. Some technological factors such as proper software and hardware or bandwidth can play a crucial role in e-learning outcomes (Keramati, Afshari, & Kamrani, 2011). Low speed internet and problems while using the system may result in student dissatisfaction and lead to students dropping out from the course. Therefore, it is necessary to assess the technological readiness for e-learning before the implementation of an e-learning system in order to realize the benefits of e-learning and reduce the challenges during e-learning implementation (Alshaher, 2013). For this reason, the measurement of e-learning readiness is essential to support successful e-learning implementation in higher education (Rohayani, Kurniabudi, & Sharipuddin, 2015).

Having introduced the concept of e-learning, the remainder of this paper is structured as follows: Section 2 presents a review of e-learning readiness models and frameworks. Section 3 discusses the reviewed e-learning models and frameworks. Section 4 presents the conclusion and the future directions for our work.

## 2. E-Learning Readiness Models and Frameworks: A Review

Different factors affect the implementation and effectiveness of e-learning in the education environment, but readiness is the critical success factor in the successful adoption of the e-learning mode of acquiring knowledge (Albarrak, 2010). This section presents a review of the various models on e-learning readiness in the literature. These models have been developed to identify the factors that affect e-learning readiness in various work settings.

Darab and Montazer (2011) proposed a model for assessing e-learning readiness in higher education in Iran (Figure 1). In this model, the technological aspects can be determined in the form of readiness related to the equipment, security and communication network. The factors identified by the model include policy, networks, equipment, management, standards, content regulations, financial and human resource sources, culture and security. Policies and standards are necessary to make any system or operation work effectively and in a uniform manner. Management of the e-learning mode includes the formulation of the required rules and the design of an effective management system. In addition, the network element should be clearly assessed in order for e-learning to be successfully accomplished because the deliberate architecture of an appropriate network will assist the teacher to better catalyze and motivate the students in the learning process as a vital and life-long behavioral trait (Almada de Aseencio, 1996). Culture is identified as a factor that significantly contributes to the e-learning environment: the culture must be such that the teachers, students and employees understand the important advantages of e-learning and accept the use of the system. Equipment is essential to make the system work as it is based on technology and technological equipment. According to Bridges et al. (2014), a centralized system is adopted in almost all e-learning modes as highly efficient management is required to make the e-learning mode function easily and to benefit the institute and the students in acquiring their goals through e-learning.
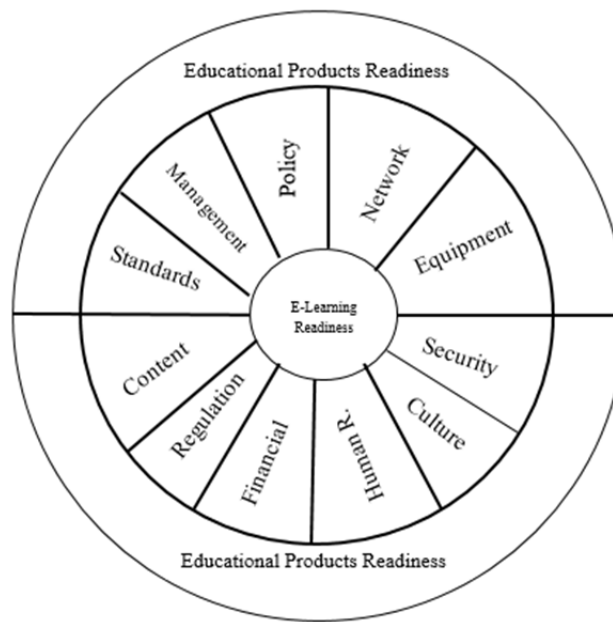
Figure 1. Framework for assessing e-learning readiness (Darab & Montazer, 2011)

Akaslan and Law (2011) investigated the extent to which HEIs in Turkey were prepared to include e-learning as part of their learning business. They identified various factors that affect the readiness for e-learning in a developing country where education is given significance and, due to changing living patterns, the educational institutions are moving from traditional learning modes to e-learning modes. These e-learning factors are based on two beliefs: that e-learning will reduce the efforts required from teachers and at the same time increase the educational level, and that some training is needed for students as well as for teachers in order to move from traditional learning to the e-learning mode. These beliefs affect the perceptions of the related entities. According to Ford, Ford, and D'Amelio (2008), when a change is implemented, it initially faces some issues and resistance but later on will be accepted. This process is reflected in Akaslan and Law's e-learning model (Figure 2). In the first phase of readiness, it is essential to consider four aspects, namely, the people, technology, content and institution. Resistance is to be expected from people who are concerned about the implementation of e-learning along with the institution as it inculcates e-learning in its activities.

The technological aspects in Akaslan and Law's (2011) model are the hardware, software and stability of the internet. Hardware refers to the physical components, and software refers to the information aspect of technology. This requires having access to the internet with a PC or laptop as the hardware along with a web browser such as Internet Explorer or Firefox as the software. In the second phase, when the users identify the benefits of e-learning, they accept the e-learning mode and consider it to be useful. In the third phase, training is given in order to completely adapt to the e-learning mode. Learners, teachers, facility managers (i.e. the managers of the university facilities that are relevant to e-learning) and other personnel (i.e. the employees whose roles are relevant to e-learning) are included in this training.
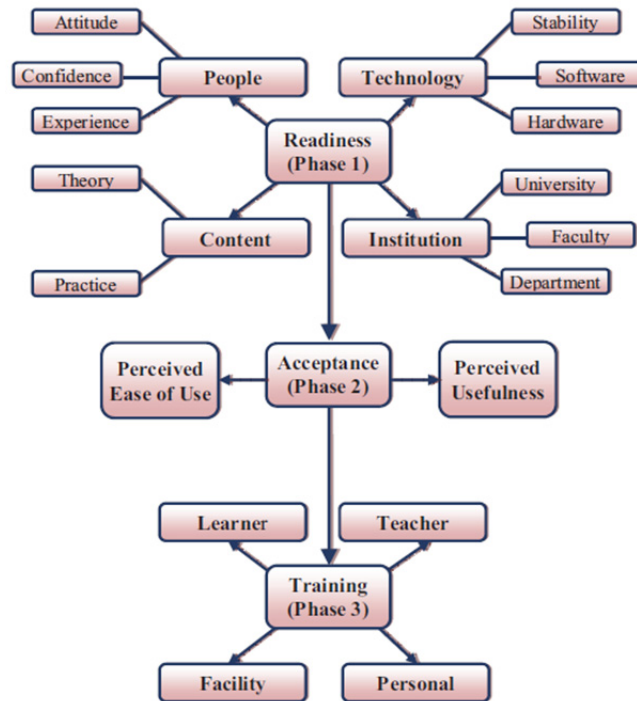
Figure 2. Model for measuring students' readiness for e-learning (Akaslan & Law, 2011)

Keramati et al. (2011) designed a model to determine the effect of factors affecting the outcomes of the e-learning process in high schools (Figure 3). The factors that affected the e-learning most included the perceptions of students and teachers along with IT and support. Moreover, readiness factors were found to include technology, organizational factors and social factors. The interaction of e-learning factors and readiness factors creates an effect on the outcomes of e-learning. If the interaction is positive, then the benefits will also be positive; if the interaction is negative, it leads to no or pessimistic results for the teacher, student and the institution. The positive interaction is appreciable and leads to teachers' progress in terms of reaching more students within a limited time along with higher flexibility, and leads to students' progress in terms of gaining higher knowledge through a variety of resources and books available online. Flexibility and convenience are positive points for both students and teachers as they can learn or make others learn from any location. The benefits to the HEI include an increase in the education level and an increase in the number of students graduating each year, resulting in an increased literacy rate. The technical readiness factors in this study included the hardware, software, content, internet access and bandwidth.
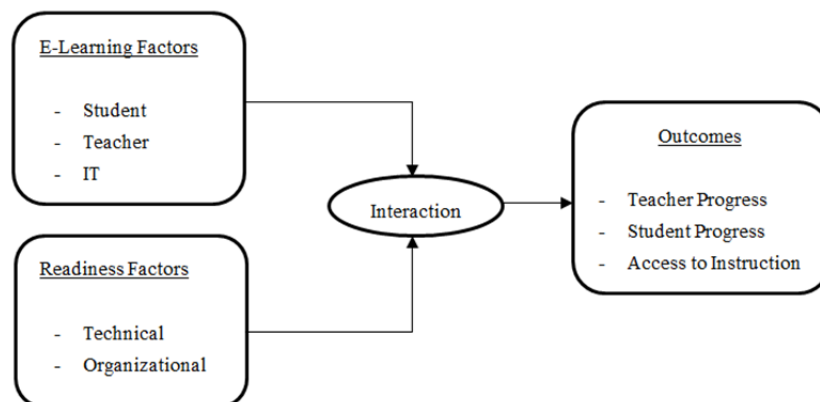


Figure 3. Conceptual model of factors affecting e-learning outcomes (Keramati et al., 2011)

(Omoda & Lubega, 2011) conducted a study to identify the factors that affect the e-learning readiness process implemented by HEIs in Uganda. They proposed ways to encourage the use of e-learning systems in order to increase access to education and improve the educational level in Uganda. They collected and analyzed data from eight institutions. The analysis revealed that the factors that affect the implementation of e-learning systems and that are therefore important to consider include awareness, culture and technology along with pedagogy and content. Regardless of the particular country in which the e-learning is to be implemented, these factors are significant and need to be considered and managed well in order to reduce the resistance level and to increase the outcomes that are to be attained. The model developed by (Omoda & Lubega, 2011) (Figure 4) depicts a hierarchy of factors, with awareness and culture having the most effect on implementation and readiness, followed by technology, pedagogy and content.

The study by (Omoda & Lubega, 2011) further found that level of awareness about technology and learning methods can help in facilitating the implementation of e-learning systems. Culture is another aspect that can affect the implementation, as culture is a combination of values, beliefs, norms and behaviors that are followed by the teachers and learners and by the institution. An e-learning project may face resistance due to culture; therefore, organizations wanting to embrace a successful e-learning strategy must ensure that they are fully prepared culturally. Technology is an essential consideration as the latest technology facilitates effective implementation. Moreover, pedagogy is a vital consideration as the way of teaching and learning in e-learning differs from the traditional teaching system and teachers need to be trained in order to teach well through e-learning. The technological aspects in the study were about the availability of resources for e-learning: for example, a sufficient number of computers in the computer laboratories and the provision of reasonably fast and stable internet services in the institute.
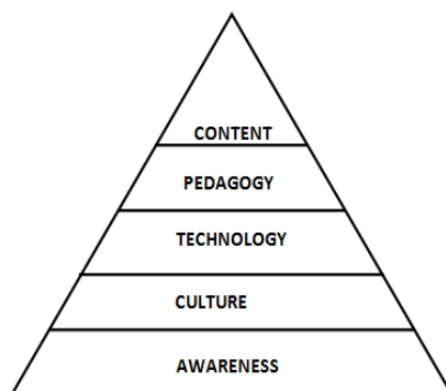


Figure 4. Model for e-learning institutional readiness assessment (Omoda & Lubega, 2010)

Alshaher (2013) proposed an e-learning system readiness assessment (ELSRA) model based on McKinsey's 7S model utilizing fuzzy logic analysis (Figure 5). The 7S model comprises strategy, structure, systems, style/culture, staff, skills and shared values. If properly followed, consideration of these elements can assist the implementation of a new system or project. Alshaher collected data through interviews and questionnaires and identified 23 7S-related factors that affect ELSRA in HEIs in Iraq. These factors can affect the implementation and result in strengths or weaknesses in the e-learning system. A proper strategy is to be formulated in the first place in order to determine the organization's goals and objectives that are to be achieved by all its functions. It includes the vision and the mission that is divided into goals and objectives through strategic plans that help the organization respond to changes in the external environment and remain competitive. The structure to be followed in the implementation of an e-learning system includes centralization to take decisions on a single basis as e-learning is similar for everyone and is not customized. Moreover, the size of the organization and the role of the chief information officer can also facilitate the implementation of an e-learning system.

In this model, the system includes: technology, content, platform support, documentation and style. In order to get higher benefits, easy access to technology and the internet is to be made available for the learners and teachers. Content is to be designed to be effective and highly beneficial along with regular amendments in order to inculcate the latest knowledge and utilize the latest resources. Documentation is essential to reduce the technology gap between the learner and the teacher. Style includes culture, leadership, communication and top management support. Higher levels of top management support will lead to higher levels of e-learning readiness among the teachers and learners. According to Goi and Ng (2009), top management support consists of three

parts, namely, technological support, funding support, and experiencing support. The culture should be developed in a way that encourages the use of e-learning and the leadership style to be followed should be transformational in order to include various innovative means and methods to acquire knowledge. Decision making and problem solving are also important leadership skills required to deal with the issues faced in the initial stages of e-learning implementation. Communication should affect not only the direct stakeholders but should include all of those who are part of e-learning including technicians, lecturers and management.

In Alshaher's (2013) model, the staff component includes sufficient manpower, project team, trust and training and learning. Without the support of the staff, effective implementation of an e-learning system is not possible. Skills are the competencies of the organization and that of management, IT staff and students. The shared values include the beliefs of the people that can help in accepting or creating resistance to the e-learning system. The technology aspects in this model include: computers (that should be available to learners), the hosting network (capable of providing the content at speed), the security level, and IT support to help learners and solve technological problems such as speed and reliability issues with the internet.
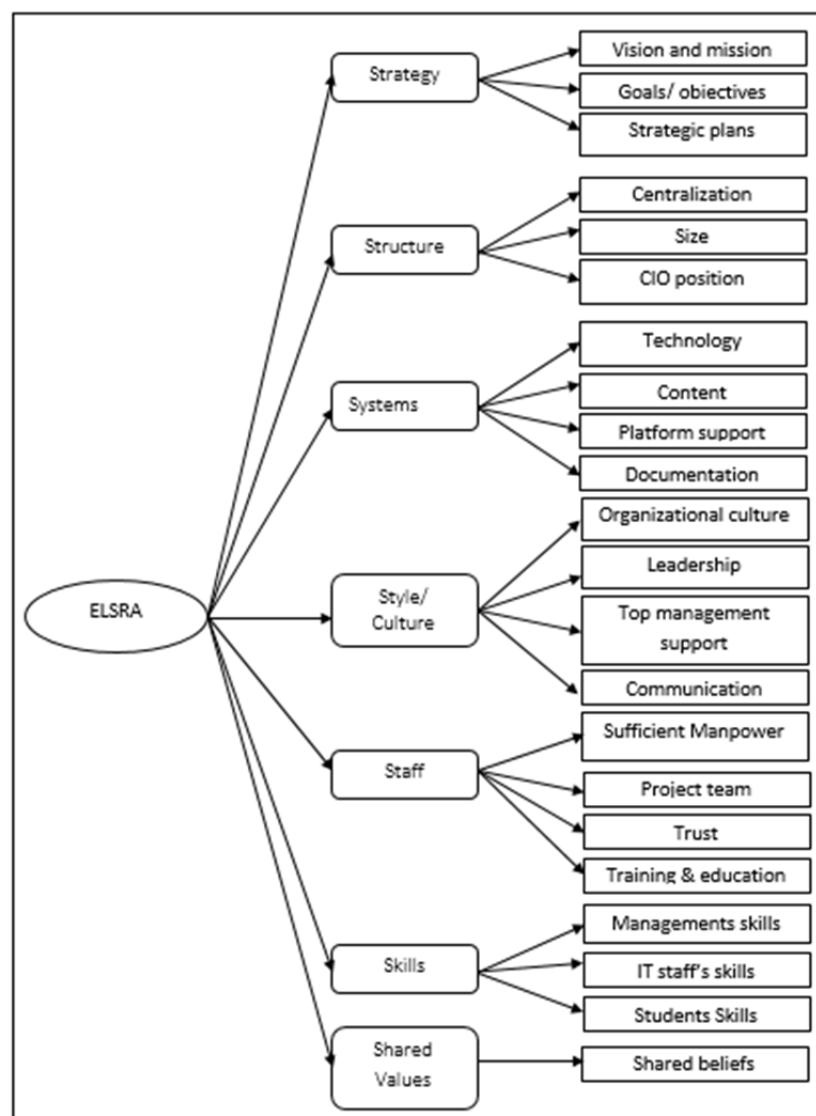


Figure 5. Model for e-learning system readiness assessment (Alshaher, 2013)

Engholm and McLean (2001) proposed a model (Figure 6) that identifies an organization's need for e-learning and the factors in e-learning readiness. The need for e-learning is identified by external sources and need analysis; e-learning emerges as a solution when there is a need to cater to diverse learning needs accompanied by

convenience and quality but less cost in order to provide learners with a competitive edge. The factors affecting e-learning readiness include organizational culture, individual learners and the technology at large. These three factors are considered as organizational and industry factors. Handling these factors well results in e-learning readiness. This model guides managers and personnel in the field of training and development in their respective organization's e-learning readiness assessment.

Engholm and McLean (2001) stated that, in order to ensure a successful e-learning experience, organizational culture is to be supportive of learning, self-directed learning is to be followed, training and development is to be highly observed, e-learning is to be aligned well with the organization's goals, and the organization is to be managed as a learning organization to support and encourage learning. Individual learners are directed in such a way that they take responsibility and manage their time well, are provided with enough flexibility but encouragement to learn, possess basic technical and learning skills, are computer literate and are willing to share information and knowledge along with the ability to gain knowledge from a variety of sources. Content is to be adequately provided to learners from a variety of sources. The content should be user friendly and accommodate different learning styles. Technological factors are to be catered for well by giving learners access to technology and user-friendly technology. Learners are to have adequate hardware and software with proper internet connection and bandwidth, along with supported versions of the latest software.
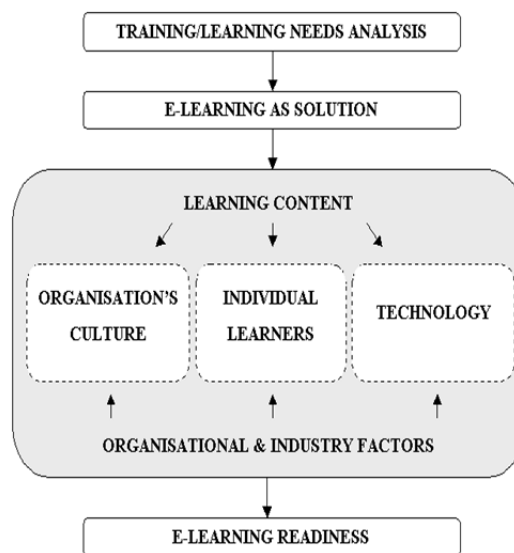


Figure 6. Model for e-learning readiness (Engholm & McLean, 2001)

Lopes (2007) proposed a model to evaluate the e-learning readiness of a HEI (Figure 7) and reported the results of its application. The model shows that the business, technology, content, culture, human resources and financial resources affect the e-learning readiness. E-learning can only be accepted if it is aligned with business aims and objectives and leads to the effective accomplishment of the business aims. Technology infrastructure is to be aligned in order to support the e-learning; a centralized system is effective. The content to be delivered through e-learning should be of high quality and standards, as well as easily understandable. The technical language is to be at the level of learners. In addition, the content is to be from a variety of sources. The institution is to be financially strong, as e-learning in the initial stages requires a high amount of capital. This spending should be seen as an investment rather than as a cost as it leads to higher benefits in the long term. The culture should encourage e-learning readiness and innovative learning. Moreover, the human resource of sound knowledge is to be maintained to ensure successful transition from traditional learning to the e-learning mode. The e-learning system must have enough support along with teachers who will be able to make the system a success. The technology aspects in this model focus on the HEI's technological infrastructure and on the degree of access to computers and the internet.
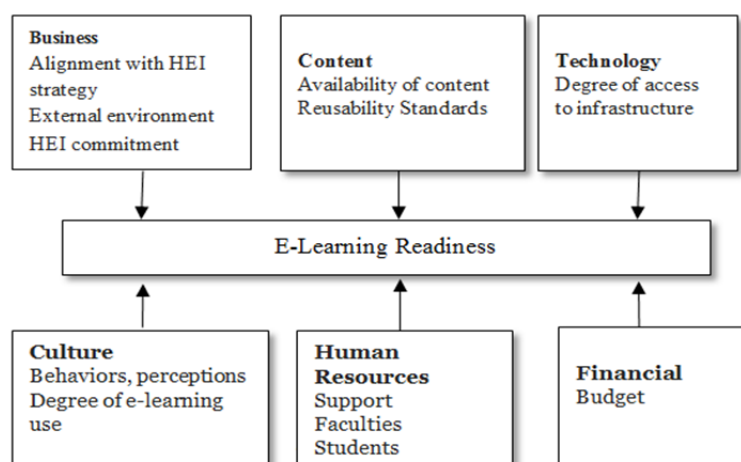
Figure 7. E-learning readiness dimensions (Lopes, 2007)

Chapnick (2000) proposed a framework to assess organizational readiness for e-learning whereby, in order to measure the readiness to adopt e-learning, it is necessary that the factors associated with psychological readiness, sociological readiness, environmental readiness, human resource and other factors are analyzed (Figure 8). Analysis of the eight categories as facilitated by the framework leads to the assessment of e-learning readiness and identifies the factors that are necessary for the successful implementation of e-learning. Furthermore, it is necessary that the identified factors are evaluated collectively in order to determine the overall readiness to adopt e-learning.

The eight categories in Chapnick (2000) framework are used to analyze the overall e-learning readiness and the factors associated with it. It is observed that this model also considers the factors related to financial and sociological readiness. The model identifies that, for the successful assessment of readiness to adopt and implement e-learning, it is extremely important that the financial capability should be considered in addition to the sociological factors that determine the overall readiness to adopt e-learning. These sociological factors include the overall culture and the perceptions of individuals regarding the implementation of the new and innovative technology of e-learning and the overall process of acquiring education. The technological aspects related to readiness in this model are equipment and technological skills.

| E-Learning Readiness Factors | Explanation of Factors |
|---|---|
| Psychological readiness | The effect of an individual's state of mind on the outcome of the e-learning initiative. Considered a particularly important factor, because it can sabotage the implementation process |
| Sociological readiness | The interpersonal aspects of the environment within which the e-learning program will be implemented |
| Environmental readiness | The major forces operating on stakeholders, both inside and outside the organization |
| Human resource readiness | The availability and design of the human support system |
| Financial | The budget size and allocation process for the e-learning program |
| Technological skill (aptitude) readiness | The observable and measurable technical competencies of the organization and individuals involved |
| Equipment readiness | Possession of the proper equipment |
| Content readiness | The subject matter and goals of construction |

Figure 8. E-learning readiness framework (Chapnick, 2000)

Psycharis (2005) proposed a model for the assessment of e-learning readiness in an educational system at a country level (Figure 9). In the model, several factors need to be considered under the categories of resources, education and environment. The factors in the resources category determine the technological readiness, economic readiness and human resource readiness. The education category refers to the readiness related to content and the overall educational readiness. The environment category includes leadership, culture and entrepreneurial readiness. The three categories comprise eight factors that are used to assess the overall readiness to adopt and implement e-learning. These factors are extremely important for the success of an e-learning system; hence, it is necessary that they should be considered and evaluated to ascertain the level of readiness among the general public to adopt the new concept of e-learning.

The three categories of assessing e-learning readiness in Psycharis (2005) model take the factors associated with e-learning in a holistic view in order to analyze the ability and willingness of the users for whom the e-learning is being implemented. The environment and resources categories are extremely important in this case as they analyze the exact capacity related to the technology, human resource and economic readiness. At the same time, the environment category analyzes the support from the leadership and the overall environment regarding the adoption of e-learning. The technological aspects related to readiness in this model include hardware, software and access to the internet.
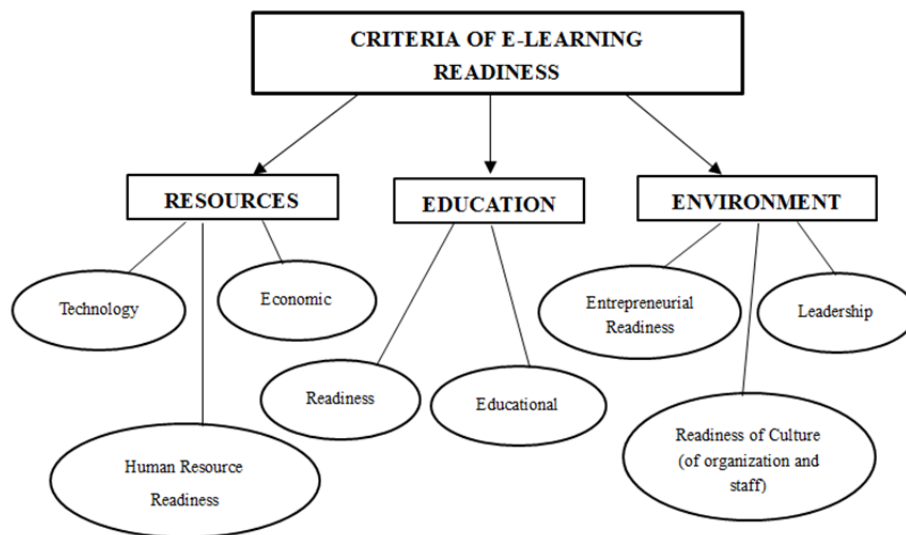


Figure 9. Criteria of e-learning readiness model (Psycharis, 2005)

Aydin and Tasci (2005) proposed a model that identifies four areas that determine the overall readiness to adopt e-learning in an organization, namely, technology, innovation, people and self-development (Figure 10). The factors identified in the model collectively determine the ability and willingness of an organization to adopt e-learning. The area of technology includes the access to computers and the internet and the ability of individuals to use such facilities. The model includes the attitudes of users towards the adoption of e-learning as an important aspect of assessing e-learning readiness. The model further includes the education level of employees as another factor that influences the overall readiness to adopt e-learning. The budget of an organization and the self-belief among the employees are other factors that determine the overall readiness to adopt and implement e-learning.

The categories of resources, skills and attitude are also well considered in this model to determine the overall readiness to adopt e-learning. Aydin and Tasci (2005) identified that these factors facilitate the successful implementation of an e-learning system in an organization as they determine the necessary requirements for the new technology of e-learning and the factors associated with it.

|  | Restores | Skills | Attitudes |
|---|---|---|---|
| Technology | Access to computers and the internet | Ability to use computers and the internet | Positive attitude toward use of technology |
| Innovation | Barriers | Ability to adopt innovations | Openness to innovations |
| People | • Educated level of employees<br>• Experienced HR specialist<br>• An e-learning champion<br>• Vendors and external parties | Ability to learn via/with technology | |
| Self-Development | Budget | Ability to manage time | Belief in self-development |

Figure 10. E-learning readiness model (Aydin & Tasci, 2005)

## 3. Discussion

The review of e-learning readiness models in the previous section identified that there are various factors that can be used to measure readiness for e-learning implementation in HEIs. Table 1 presents a comparison of the e-learning readiness factors in the literature.

Table 1. Comparison of factors related to e-learning readiness

| Components /Factors | Darab and Montazer (2011) | Akaslan and Law (2011) | Keramati et al. (2011) | Omoda-Onyait and Lubega | Alshaher (2013) | Engholm and McLean (2001) | Lopes (2007) | Chapnick (2000) | Psycharis (2005) | Aydin and Tasci (2005) | Total | Frequency |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Technology | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ | 10 | 1 |
| Learners | √ | √ | √ | | √ | √ | √ | | √ | √ | 8 | 2 |
| Content | √ | √ | | √ | | | √ | √ | √ | | 6 | 3 |
| Resources | √ | √ | | | | | √ | √ | √ | √ | 6 | 3 |
| Social and cultural | √ | | √ | √ | | √ | √ | | | | 5 | 4 |
| Awareness | | | √ | √ | | | | √ | √ | √ | 5 | 4 |
| Equipment | √ | | | | | | | √ | √ | √ | 4 | 5 |
| Management | √ | | | | √ | | | | √ | | 3 | 6 |
| Standards | √ | | | √ | | | | | | √ | 3 | 6 |
| Institution | | | √ | √ | | | | | √ | | 3 | 6 |
| Acceptance of e-learning | | √ | | | | | | | | √ | 2 | 7 |
| Pedagogy | | | | √ | | | √ | | | | 2 | 7 |
| Human resources | | | | | | | | √ | √ | | 2 | 7 |
| Financial | | | | | | | | √ | √ | | 2 | 7 |
| Security | √ | | | | | | | | | | 1 | 8 |
| Laws and Regulations | √ | | | | | | | | | | 1 | 8 |
| Training procedure | | | | | | | | | | √ | 1 | 8 |

The comparison in Table 1 shows that, among the factors that are identified in the literature as the important factors to be considered in e-learning readiness assessment, the factor with the highest frequency is technology, followed by learners (at the second highest frequency), and then content and resources (both at the third highest frequency). Social and cultural factors and awareness are not far behind on the list of the most important factors to be considered in assessing e-learning readiness (both at the fourth highest frequency). The comparison shows that equipment is another factor that determines the e-learning readiness (at the fifth highest frequency), as well as management, standards and institution (at the sixth highest frequency. The factors of pedagogy, human resources, acceptance of e-learning, financial, security, laws and regulations and training procedure are recognized in the literature as important factors that influence e-learning readiness, but with low frequency.

As shown in the comparison of various models in Table 1 above, technology appears with the highest frequency in the literature and is therefore identified as the most important factor among all factors in e-learning readiness. This result attracted our attention and motivated us to learn more about the technological aspects that influence e-learning readiness. We therefore compared the factors related to the technological aspects of e-learning readiness in the ten models and frameworks that were reviewed above in Section 2. Table 2 presents a summary of the comparison.

Table 2. Comparison of factors related to technological aspects of e-learning readiness

| Factors of Technology | Darab and Montazer (2011) | Akaslan and Law (2011) | Keramati et al. (2011) | Omoda-Onyait and Lubega (2011) | Alshaher (2013) | Engholm and McLean | Lopes (2007) | Chapnick (2000) | Psycharis (2005) | Aydin and Tasci (2005) | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Internet access | | √ | √ | √ | √ | √ | √ | | √ | √ | 8 |
| Hardware | √ | √ | √ | | | | | √ | √ | | 5 |
| Availability of computers | | | √ | | √ | √ | | | | √ | 4 |
| Software | | √ | √ | | | | | | √ | | 3 |
| IT support | | | | | √ | √ | | | | | 2 |
| Technical skills | | | | | | | | √ | | √ | 2 |
| Security | √ | | | | √ | | | | | | 2 |
| Communication network | √ | | | | | √ | | | | | 2 |
| Infrastructure | | | | | | | √ | | | | 1 |

On the basis of the summary in Table 2, it is observed that there are several technological factors that influence the overall readiness to adopt and implement e-learning. The comparison of these technological factors indicate that internet access, hardware and availability of computers are commonly emphasized in all of the models. On the other hand, a few studies emphasized software, IT support, technical skills, security, communication and infrastructure. Thus, the analysis of these models leads to the conclusion that these technological factors are not considered in every model and there is no single model that encompasses each of the identified factors. There are factors that are missing from some models but are reported in other models. For example, the IT support factor is not mentioned in seven of the ten reviewed models but is mentioned in three of the reviewed models which recommend that IT support should exist to help learners if something goes wrong and to solve problems such as network issues (Engholm, 2002). IT support is important in the successful implementation of e-learning as, without this factor, the general consumers of this new technology would not be able to adopt it (Ghavamifar, Beig, & Montazer, 2008). From our point of view, the IT support factor is extremely important in the successful implementation of e-learning. The lack of appropriate IT support in the higher education sector results in subsequent challenges and barriers for students. This lack of IT support can complicate the entire process of attaining education and would influence the overall readiness of individuals to accept this new and innovative technology. The network and internet settings in addition to the hardware requirements that are necessary for successful implementation of e-learning system are difficult for most students to manage; hence, students require appropriate IT support and expertise to acquire their education electronically.

The security factor is included in two of the ten reviewed models and is missing from the remaining eight models. According to Alshaher (2013), the aim of security is to adopt various approaches for securing both individual and organizational information, ensuring the authenticity of the transmitted information, preventing the intrusion of hackers into the educational environment, and maintaining a safe environment for all users (whether they are students, professors, administrators or managers). Aydin and Tasci (2005) claimed that, among the various factors, the security factor is one of the most important factors that influences the readiness to adopt e-learning in higher education. It is observed that the lack of security prevents individuals from accepting this new technology

and benefiting from it. Similarly, Omoda-Onyait and Lubega (2011) argued that the lack of security should be considered in assessing the readiness of individuals to accept e-learning. A lack of security results in fear among the typical education-seeking individual, because of which they resist the new concept. From our point of view, security is one of the most important factors that influences the readiness to adopt e-learning in the higher education sector especially because an e-learning system is prone to several security threats such as hacking and malware viruses. These intentional security breaches not only harm the hardware that individuals are using but also hamper the overall process of acquiring education and knowledge through e-learning.

The technical skills factor is included in three of the reviewed models while it is missing from the remaining seven models. This factor refers to the ability of individuals to use computers and the internet (Oketch, Njihia, & Wausi, 2014). If the participants in e-learning do not have the skills to use the technology and learn the content, e-learning will not succeed (Berge, Collins, & Dougherty, 2000). Thus, we conclude that the technical skills factor is important for the successful adoption of an e-learning project, as the lack of technical skills will result in individuals' resistance to e-learning technology.

The infrastructure factor is included in one of the reviewed models. The infrastructure related to e-learning includes hardware, networks, computers, software and the internet (Guruvadoo (2003); Mohammad and Job (2012). Accordingly, we note that some of the factors related to infrastructure are included in some models, such as internet access, hardware, software, availability of computers and communication network. According to Lopes (2007), the implementation of an e-learning system is also dependent on the available infrastructure. The non-availability of the required infrastructure influences the readiness to accept e-learning as it becomes extremely challenging and difficult for the users (e.g. students) to access the new technology (Laohajaratsang, 2009). Moreover, the lack of appropriate infrastructure increases the costs of adopting e-learning which is a significant factor in assessing e-learning readiness. Hence, it is concluded that the implementation of a new and innovative e-learning system should be accompanied by the enhancement and modernization of the available infrastructure. This would include the following components:

*Internet access* – Most of the reviewed models identify access to the internet as one of the most important technological factors that determine the readiness to adopt e-learning. For e-learning to succeed, access to the internet should be easy. In addition, Omoda-Onyait and Lubega (2011) pointed out that access is not the only issue related to the internet: the speed and availability of the service are other factors related to the internet. Borotis and Poulymenakou (2004) argued that, in order for an e-learning system to be successfully adopted, it is necessary that a reliable internet service with the required speed is available. The lack of appropriate internet infrastructure, speed and reliability affects the readiness of a country to adopt e-learning in its higher education system and ensure that students are able to benefit from the various advantages of e-learning. The adoption of e-learning requires a bandwidth which is sufficient for transferring the video and audio forms of communication that are essential elements of e-learning (Schreurs, Ehlers, & Sammour, 2008). The assessment of the importance and significance of the internet in the evaluation of e-learning readiness indicates that the availability, reliability and speed of the internet are the main factors that determine the overall readiness of individuals to accept e-learning. We therefore note that the most important factor among the technological aspects of e-learning readiness is the internet. The internet factor is further subdivided into the components of access, bandwidth, broadband and speed and reliability. The assessment of the importance and significance of the internet in the evaluation of e-learning readiness indicates that the affordability, availability, reliability and speed of the internet are the main factors that determine the overall readiness of individuals to accept e-learning.

*Hardware* – Hardware refers to the physical components of technology (Aydin, & Tasci, 2005). The hardware part of e-learning includes the physical equipment that must be available and able to supply e-learning (e.g., computers, servers and networks) along with equipment for end-users to be able to access the services. Without appropriate equipment and easy access, it is difficult, if not impossible, to implement any e-learning (Oliver & Towers, 2000). According to Akaslan and Law (2011), any assessment instrument should include identification of the available hardware such as computers and network connection. We note that all of the reviewed models include hardware as an important factor among the technological aspects of e-learning readiness. Some of the models mention the hardware factor and other models mention the availability of computers as a factor which is related to hardware. Thus, the access and availability of the hardware required to successfully implement the e-learning concept are important factors that determine the overall readiness of individuals to adopt e-learning in higher education.

*Software* – Software refers to the information management tools that help the user perform certain tasks (Aydin & Tasci, 2005). In the e-learning environment, software includes operating systems, learning management systems and application systems such as browsers among other relevant applications. The successful adoption of e-learning requires at least the minimum hardware requirements and the software required to use that hardware.

This factor is included in three of the reviewed models and is missing from the remaining seven models. From our point of view, the software factor is required for the successful implementation and adoption of e-learning; therefore, it is highlighted as one of the most important factors that determine e-learning readiness in higher education.

To sum up, a number of e-learning readiness models are proposed in the literature but there is a lack of agreement on the necessary factors related to the technological aspects of e-learning readiness. Some of the technological factors are included in some models but are missing from other models. Hence, a clear gap is identified in the literature regarding the technological aspects of e-learning readiness.

## 4. Conclusion

The use of e-learning is an attractive teaching and learning strategy for many HEIs around the world. Therefore, it is important to assess e-learning readiness, including the technological aspects of readiness, in order for the implementation and adoption of e-learning to be successful. The goal of this paper is to explore the gaps in knowledge regarding the technological aspects of e-learning readiness. This paper presented a review of the models and frameworks for assessing e-learning readiness. The review showed that there is a lack of investigation and agreement about the factors that shape the technological aspects of e-learning readiness; hence, a clear gap is identified in the knowledge on the technological aspects of e-learning readiness. This work indicates a useful direction in future research to investigate the factors related to the technological aspects of e-learning readiness. Hence, future research will be conducted to generate a list of the factors shaping the technological aspects of e-learning readiness. This list will help HEIs to identify and understand the technological aspects that must be considered when assessing the readiness to adopt e-learning. In addition, the list of technological readiness factors can be used by designers and developers as a guideline for identifying the necessary technological requirements for e-learning implementation.

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