Functional Requirements to Increase Acceptance of M-Learning Applications among University Students in the Kingdom of Saudi Arabia (KSA)

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Abstract
The acceptance of smartphone applications in the learning field is one of the most significant challenges for higher education institutions in Saudi Arabia. These institutions serve large and varied sectors of society and have a tremendous impact on the knowledge gained by student segments at various ages. M-learning is of great importance because it provides access to learning through a wide range of mobile networks and allows students to learn at any time and in any place. There is a lack of quality requirements for M-learning applications in Saudi societies partly because of mandates for high levels of privacy and gender segregation in education (Garg, 2013; Sarrab *et al.*, 2014). According to the Saudi Arabian education ministry policy, gender segregation in education reflects the country's religious and traditional values (Ministry of Education, 2013, No. 155). The opportunity of many applications would help the Saudi target audience more easily accept M-learning applications and expand their knowledge while maintaining government policy related to religious values and gender segregation in the educational environment. In addition, students can share information through the online framework without breaking religious restrictions. This study uses a quantitative perspective to focus on defining the technical aspects and learning requirements for distributing knowledge among students within the digital environment. Additionally, the framework of the unified theory of acceptance and use of technology (UTAUT) is used to modify new constructs, called application quality requirements, that consist of quality requirements for systems, information, and interfaces.

Keywords: *M-learning, Mobile Learning, UTAUT, KSA, MOE, Application Quality*

1. Introduction

For the purposes of this study, mobile learning (M-learning) environments represent one of the largest technological environments in the current decade for increasing knowledge (Jaradat, 2014). M-learning is defined as learning by using smart devices such as smartphones, tablets, or handheld devices to learn and increase personal knowledge through electronic material (Al-Barhamtoshy & Himdi, 2013). With the explosion of the information revolution, the online learning process has many challenges and opportunities to improve application design for both academic research and M-learning. The technology comprises integrated tools for use on mobile platforms providing learning features for the current and future eras.

The education policy in Saudi Arabia is dictated by the government's policies, which reflect Islamic regulations. Therefore, this study focused on M-learning application requirements that would be beneficial from an educational perspective in specific and special regulatory contexts. The study's importance is in identifying what students seek to gain via M-learning within the framework of the Islamic background of Saudi society, where Islamic regulations prohibit the genders mixing at all education levels (Ministry of Education [MOE], 2017, No. 155). These policies make significant and important differences in Arabic communities when compared to Western regions of the world. The policies in other countries give students equality, and genders mix in classes at all levels of education.

There are shortfalls to be addressed in the quality of education and its opportunities for Saudi communities due to the requirements for a high level of privacy and separation of genders in education (Garg, 2013; Sarrab *et al.*, 2014). Currently, more than 75% of mobile subscribers in Saudi Arabia are using smartphone devices for many activities of daily life (eMarketer, 2015). Thus, it is important to consider strengthening the M-learning approaches by determining the factors required to produce an M-learning application that is acceptable to students in Saudi universities. There are several opportunities to help the target audience more readily accept learning applications, allowing this community to expand their knowledge while maintaining adherence to government policies associated with religious values.

M-learning applications have many potential factors to be implemented along with meeting the specific design requirements for use in Saudi communities and allowing students to share information without breaking the religious restrictions of Saudi society. Many previous studies have focused on the factors influencing M-learning's acceptance in the Kingdom of Saudi

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Arabia (KSA); however, there is a shortage of information about the main practical requirements influenced by particular societal or traditional factors specific to the KSA. These requirements will be helpful for designing professional application functions, but they will also assist in analysing an application for M-learning to determine the app's suitability and resources for M-learning environment knowledge sharing in higher education institutions in the KSA.

Quantitative methods were used to collect and analyse data from the target population using a research questionnaire to answer the research question and identify the target requirements that could be beneficial in designing an M-learning application acceptance model. The sample size for this study was fairly sizeable at 539 participants.

The remainder of this paper is laid out as follows. In this section, some background on M-learning is provided. Section 2 is a review of the literature, followed by the theoretical framework for this study in Section 3. Section 4 gives the analysis and main findings in the data, and Section 5 is the discussion of the results. The paper concludes with a discussion of the implications of the study in Section 6 and the conclusion in Section 7.

1.1 M-learning Definition

The phrase "mobile learning" (M-learning) has become increasingly familiar in the current decade. It is used in a variety of ways in relation to modern teaching techniques and in meeting the changing needs of education institutions and communities (Behere, 2013). This adaptation reflects the increasing role played by mobile devices in the educational process, specifically, and in our daily lives, more generally.

M-learning can be defined as learning that is mediated by small portable computers, which may include smartphones, PDAs, and similar handheld devices such as laptops, including ultra-laptop computers in this group (Chen & Huang, 2010; Melhuish & Falloon, 2010). Some previous studies have suggested that connecting to the Internet for learning purposes using a 3G network is the defining feature of M-learning, so any device used for learning with the same method (3G or 4G network, Wi-Fi, GPRS, SIM card) could fit this perspective, extending the definition to tablets and also personal media players (Kukulska-Hulme & Traxler, 2005; Laurillard, 2007; Melhuish & Falloon, 2010; Traxler, 2009). Additionally, the ability to create a curriculum and learning activities and assessments that help learners reach the outcome goals for a particular course of study is among the opportunities that are afforded by the mobile platform; this advantage represents one of the main strengths of M-learning (Nassuora, 2012).

There are various other definitions of M-learning. As a subset of e-learning, which is learning at the right time and in the right place with access to educational materials and communication with colleagues or with teachers at other educational institutions (Ally, 2009; Peters, 2007), it is the central affordance of mobile technologies to facilitate learning, which is the key factor in any definition of M-learning.

1.2 M-learning Is Becoming Widespread Globally

One obvious reason for the increasing importance of M-learning and the use of smart devices for online learning is the improvements in the technologies that have emerged during the past decade (Dhaheri & Ezziane, 2015). This progress has in turn contributed to reducing the cost of these devices in comparison to desktop computers, leading to greater numbers of mobile device users in many countries (Balaji *et al.*, 2016; Communications and Information Technology Commission [CITC], 2017). These smart devices offer many features beyond those of desktop computers, such as cloud storage, instant Internet access, and ongoing connectivity (Wang *et al.*, 2009). According to the Communications and Information Technology Commission (CITC) in the KSA, in 2015, at least 68.5% of the Saudi population had access to the Internet via a mobile phone (CITC, 2017). This places Saudis third on a global basis for such usage, per individual in the population (Aitnews, 2017; eMarketer, 2015). There is an appropriate opportunity to benefit from this trend by supporting approaches that provide M-learning applications compatible with the aspirations of Saudi communities (Sarrab *et al.*, 2015). Given the capabilities of M-learning, much potential of smart mobile devices remains untapped because of the relatively low level of technological awareness and expertise, as well as users' limited acceptance and use of M-learning technology (Garg, 2013). These devices have stable specifications, storage facilities that have reached a high standard, high-speed data processing, and long battery life (Jaradat, 2014; Nassuora, 2012). Due to their range of graphic interfaces and support for various file formats, mobile devices can easily and conveniently help target learners and diffuse the M-learning approach (Chanchary & Islam, 2011).

Furthermore, there is the significance of M-learning in encompassing factors like enriching the online educational context through implementing virtual classrooms (Marinakou & Giousmpasoglou, 2014), creating and sharing knowledge through social media and learning applications (Jansen *et al.*, 2012; Morales, 2013), helping users to display, create, and update data and charts live (e.g., the Nearpod App), and facilitating online learning for people who live in regions that are only serviced by mobile networks. This is accomplished by taking advantage of features built into smart devices that do not need to be defined, unlike office-based devices such as webcams or microphones.

Furthermore, KSA residents use smart devices much more than they use desktop computers. The widespread use of mobile devices means that both male and female students can be included in learning activities without any community constraints and while maintaining gender segregation.

1.3 M-learning's Importance for Higher Education in the KSA

M-learning is a modern method that concentrates on the convergence of devices and the functions and features of smartphones. According to a study by Sarrab *et al.* (2015), most mobile devices are useful for M-learning. Many advantages are named in the literature of M-learning, including the following:

- Dimension allowing learners to practice and share their knowledge with each other.

- Using an online classroom environment requires no special skills.
- E-book devices are lighter and slimmer than textbooks.
- Online library portals provide millions of free e-books or discounted prices for students and universities.
- M-learning apps use handwriting in any writing application (e.g., the PenMail app), which is a more intuitive approach.

This level of flexibility for exchanging tasks and working collaboratively with others means that learners can benefit from the online learning environment.

In another study, Kennedy *et al.* (2008) indicated eight main activities that are beneficial in the education field, especially in higher education. These are sending and receiving pictures, videos, or audio files; accessing the Internet; making voice and video calls; sending and receiving emails; organizing notes; reading books; sending and receiving SMS or MMS messages; and providing learning environments without the limitations of time and place. Furthermore, Chong *et al.* (2011) suggested that the widespread use of mobile devices on campuses invites more integrated educational methods related to M-learning, offering much greater availability and flexibility for students.

Thus, the importance of M-learning in higher education will be more attractive to potential students for several reasons. Smart devices are lighter and easier to carry compared to desktops or even laptops; mobile devices are both useful and affordable (Abu-Al-Aish & Love, 2013); smart devices have become more acceptable because they are easy to use (Nassuora, 2012); smart devices help to increase future M-learning benefits through features designed and built with a view to future technological developments (Motiwalla, 2007); and finally, smart devices make M-learning a cooperative environment because they have social applications and offer opportunities to access study materials, including formative means of assessments and feedback between students and their teachers (Nassuora, 2012).

Mobile technology has had a positive effect on the global learning process. It is therefore not surprising that higher education institutions around the world are investing in improving and developing online means of intensive learning in order to promote and maintain the required student knowledge and skills (Al-Barhamtoshy & Himdi, 2013). Many researchers have focused on e-learning environments for M-learning in the KSA (e.g., Brown *et al.*, 2006; Chao & Chen, 2009; Liu *et al.*, 2010). Therefore, many of the country's governmental education institutions are now investing significant effort in the M-learning field based on the KSA 2030's vision of looking beyond oil to create a knowledge-based economy (Alharbi & Drew, 2014; Garg, 2013). There is now substantial funding of M-learning projects at most of Saudi Arabia's universities. Furthermore, the Higher Education Ministry was developed to oversee an ambitious National Higher Education Plan (the "Afaq Project"), including a long-term plan for higher education that addresses current and future challenges (Alali, 2015). This project focuses on the implementation of fully fledged online learning at all universities (Alali, 2015; Garg, 2013; Khan *et al.*, 2015). As a result, some related infrastructure sub-projects that have been established, such as the National Centre for E-learning and Distance Learning (NCELDE), benefit from global experiences in e-learning systems, such as Blackboard, or develop local systems such as Moodle and Classera at the core of the educational process. In addition, there are the national system for the management of e-learning (JUSUR) and the Saudi Repository for Learning Objects and the Qualification and Training Project. In addition to these systems that represent the core infrastructure for online learning, an integrated (HTML5) product has been designed especially for smartphone applications. These products should help to encourage the ongoing rapid growth of M-learning and will likely be a productive way to meet the growing demands of the expected audience for M-learning features, such as speed, flexibility, and awareness (Garg, 2013; Nassuora, 2012).

Many achievements have been reached in the current decade that have encouraged the MOE to consider making M-learning via smart devices one of the important solutions for the present and the future in Saudi Arabia, particularly after the Corona pandemic. M-learning has appeared to become particularly important in Saudi Arabia. Due to education policies in KSA that focus on gender segregation at various levels of education, there are insufficient numbers of students to warrant opening colleges and classes in order to serve both genders in many Saudi Arabian cities (Alalmai, 2009; Alwatan, 2010; MOE, 2017). Many universities in the KSA do not include colleges for both boys and girls, and it appears that this availability is especially limited for female students because some universities tend to expand on the basis of available staff, with a curriculum based on the required training for the market, and with a sufficient number of students before opening a new college or training department (Mosa, 2015). As a result, many students are required to travel to the nearest university where their specialization is available. This means limited learning is accessible for some disciplines. Providing those classes through electronic channels would be an appropriate solution for these limitations (Mosa, 2015). Moreover, many small towns and villages that do not have the ground infrastructure of telecommunication services instead use mobile networks to communicate. This leads to the likelihood that M-learning applications will be among the most important channels in education for those areas (Chanchary & Islam, 2011; CITC, 2017; Mosa, 2015). Moreover, M-learning applications might help provide a private atmosphere that is appropriate for Saudi society's requirements in accordance with the KSA's educational policies (Chanchary & Islam, 2011).

2. Literature Review

The literature in the M-learning field is rich and complex. This study focused on M-learning aspects related to developing learning applications and the impact on directly serving students. The review encompasses the unified theory of acceptance and use of technology (UTAUT) modifications and what new constructs have been added to the UTAUT framework to increase student acceptance of M-learning applications.

2.1 Modified UTAUT for M-learning Application Requirements

There are four main constructs in UTAUT that influence smart device user acceptance of M-learning. The present study retains some performance expectancy (PE) and effort expectancy (EE) constructs, but three additional constructs were included to focus on the factors that may influence a university student's acceptance of M-learning applications. A study by Liu *et al.* (2010) indicated that personal innovation has a significant impact on a student's adoption of M-learning applications. The researchers also found that personal innovation indicators help measure the perceived level of usefulness and perceived ease of use through extending the technology acceptance model (TAM) with UTAUT (Liu *et al.*, 2010). Additionally, the lecturers' influence encompasses characteristics similar to social influence, the main construct in the original UTAUT. Because the community of this study was university students, the lecturers' influence replaced the social influence construct in this study (Abu-Al-Aish & Love, 2013; Wang *et al.*, 2008). Moreover, application quality has been replaced by the construct of facilitating conditions because this study focused on identifying the technical and regulatory requirements that help increase the acceptance of M-learning applications (see theoretical framework in Figure 1).

2.2 Measures of Performance Expectancy (PE)

PE is a main construct in the UTAUT model, as are perceived usefulness in the TAM and TAM2, extrinsic motivation in the Motivation Model theory, relative advantage in the DOI theory, and Soffit in the MPCU theory. In this study, PE focuses on the degree to which the student believes that using the M-learning application via smart devices is useful and helps one achieve the main learning objectives quickly (Venkatesh *et al.*, 2003). In addition, Wang *et al.* (2009) noted that PE in UTAUT is the strongest indicator of behavioural intention (BI) to use information technology, therefore concluding that perceived usefulness is the most common factor in determining the rate of dependence on technology. Additionally, this study suggested that students would find M-learning useful because it helps them learn more quickly than traditional means, thereby improving their academic productivity (Wang *et al.*, 2009). See the measurement requirements in Table 1, where six items coded as PE1 to PE6 measure this construct.

2.3 Measures of Effort Expectancy (EE)

EE is one of the UTAUT constructs that is similar to perceived ease of use in the TAM and TAM2, ease of use in the MPCU theory, and complexity in the DOI theory. In our current study, EE represents the level of ease associated with learning applications through smart devices. This ease includes flexibility of interactions between mobile learning systems. EE can also have a direct impact on BI (Abu-Al-Aish & Love, 2013). For this reason, Vankatesh *et al.* (2003) indicated that concepts related to EE are stronger determinants of the intentions of individual users (Vankatesh *et al.*, 2003). See the measurements requirements in Table 1, where four items coded as EE1 to EE4 measure this construct.

2.4 Measures of the Lecturers' Influence (LI)

Lecturer influence is a suggested construct in the UTAUT model used in place of social influence. This construct is similar to the subjective norm in the TRA, TAM2, and TPB models, social factors in the DOI model, and image in the MPCU model. Wang *et al.* (2009) noted that the context in M-learning is not necessarily similar to that in other systems, so the original UTAUT model constructs may be insufficient when determining the user's BI. In the meantime, they suggested modifying the existing UTAUT model for M-learning applications in smart devices and consequently established lecturers' influence as a new construct (Abu-Al-Aish & Love, 2013; Badwelan *et al.*, 2016). Therefore, lecturers' influence is defined as the level of influence that would help academic trainers convince students to use M-learning services through smart devices (Abu-Al-Aish & Love, 2013; Badwelan *et al.*, 2016).

Some research has presented divergent views about lecturers' influence on students' BI to use M-learning on smart devices. For example, Gilda and Grant (2013) indicated that students are frustrated by lecturers who fail to integrate technology into their teaching because technology provides a variety of tools to help increase understanding and student information absorption (Gilda & Grant, 2013). Therefore, the influence of lecturers plays an important role in students' BI to use mobile learning systems, which should be re-tested because of the divergence of perceptions among studies related to the importance of lecturers' influence. See the measurements requirements in Table 1, where two items coded as LI1 to LI2 measure this construct.

2.5 Measures of Personal Innovativeness (PInn)

The current decade led us to consider an individual's motivation and desire to experiment with new technology, as well as a student's level of innovation, willingness to adopt new ideas, and understanding of changes in new information technology (Schuster, 2020). In addition, a number of studies have indicated the impact of personal innovation on user BI (e.g., Cheung *et al.*, 2015; Jansen *et al.*, 2012; Liu *et al.*, 2010). Therefore, it is expected that students who have a high motivation to face risk have more intention to use M-learning in their studies because it is attractive to young people who want to experiment with new technologies, especially those provided by their universities (Abu-Al-Aish & Love, 2013). See the measurement requirements in Table 1, where two items coded Pinn1 to Pinn2 measure this construct.

2.6 Measures of M-learning Application Quality (AQ)

Aladwani and Palvia (2002) defined quality in websites as the characteristics needed by users to increase the level of trust and deal with websites effectively. Gable *et al.* (2008) indicated the importance of quality in applications as one of the overall criteria for evaluating information systems from two different aspects: the impact of information systems (IS) in the past and the expected impact of quality in the future development of information systems (Gable *et al.*, 2008). The impact of IS is defined as a measure at a particular time that includes the overall net benefits in IS. The expected impact of quality measures the potential future influences of IS (Gable *et al.*, 2008). Another definition of quality impact by DeLone and McLean (1992) is the value that promotes satisfaction, appropriate use, and positive impacts on an individual or organization. Thus, quality in IS affects the capabilities and practices of IT, which will affect the quality of IS, user satisfaction, and system use. Previous studies have suggested that quality is divided into many dimensions, such as information quality, system quality, security, ease of use, user satisfaction, and service quality (e.g., Acharya & Sinha, 2013; Calisir *et al.*, 2014; Gafni, 2009; Parsons & Ryu, 2006; Sarrab *et al.*, 2015; Wong, 2015).

The quality of M-learning applications in smart devices represents a new construct that is beneficial for measuring the acceptance of M-learning applications. As Chin-ChehYi (2010) and Elmorshidy (2012) pointed out, information quality is the outcome of information system requirements that provide all relevant information. It also includes the accuracy of information and provides a mechanism for updating the information periodically (Chin-ChehYi *et al.*, 2010; Elmorshidy, 2012). Furthermore, system quality measures different dimensions of system performance, such as reliability, flexibility, ease of use, and accessibility (DeLone & McLean, 2003). Some previous research has suggested that application quality should contain three main categories: system quality, service quality, and interface quality. These represent the main requirements that should be included in the application (Badwelan *et al.*, 2017). System quality is defined as user expectations and perceptions of the performance of mobile screens in retrieving and presenting information (Badwelan *et al.*, 2017). DeLone and McLean (2003) and Seddon and Kiew (2007) noted that system quality positively affects the actual use of an application. This conclusion confirms that system quality and ease of use lead to expected benefits of M-learning applications on smart devices (DeLone & McLean, 2003; Seddon & Kiew, 2007).

Table 1: Summary of Other Studies about M-learning

No.	Measurements	Main construct	Reference
PE1.	The application is useful to accomplishing specific learning goals.	**Performance Expectancy**	Wang *et al.*, 2009; Liu *et al.,* 2008
PE2.	The application enables achieving the learning goals more quickly.		Wang *et al.*, 2009; Liu *et al.,* 2008
PE3.	The application increases students' learning productivity.		Lowenthal, 2010; Liu *et al.,* 2008; Padilla-MeléNdez *et al.*, 2013
PE4.	The application improves users' collaboration with other classmates.		Lowenthal, 2010; Liu *et al.,* 2008
PE5.	The application gradually improves students' performance.		Cheung *et al.*, 2015; Padilla-MeléNdez *et al.*, 2013
PE6.	The application helps to identify the educational goals, and assists in completing fundamental tasks.		Wang *et al.*, 2009;
EE1.	The application makes the learning more flexible and easy to use.	**Effort Expectancy**	Jairak *et al.*, 2009; Lowenthal, 2010; Iqbal & Qureshi, 2012; Ju *et al.*, 2007; Cheung *et al.*, 2015
EE2.	Multimedia files are helpful for increasing ease of use.		Lowenthal, 2010; Iqbal & Qureshi, 2012; Ju *et al.*, 2007; Cheung *et al.*, 2015
EE3.	Providing clear and understandable instructions allows the user to use the application.		Jairak *et al.*, 2009; Lowenthal, 2010; Iqbal & Qureshi, 2012; Ju *et al.*, 2007; Cheung *et al.*, 2015
EE4.	The application's features are beneficial for increasing the user's skills to use the application more easily.		Jairak *et al.*, 2009; Iqbal & Qureshi, 2012; Ju *et al.*, 2007; Cheung *et al.*, 2015
LI1.	Using the application when recommended by academic lecturers.	**Lecturers' Influence**	Jairak *et al.*, 2009; Iqbal & Qureshi, 2012; Cheung *et al.*, 2015; Padilla-MeléNdez *et al.*, 2013
LI2.	Using the application if there are technical and academic support channels available to solve any facing problems.		Ju *et al.*, 2007; Liu *et al.,* 2008; Padilla-MeléNdez *et al.*, 2013
PInn1.	Using the M-learning application without any reservations.	**Personal Innovativeness**	Lowenthal, 2010; Iqbal & Qureshi, 2012; Padilla-MeléNdez *et al.*, 2013
PInn2.	Providing online educational resources.		Iqbal & Qureshi, 2012; Ju *et al.*, 2007; Liu *et al.*, 2008; Cheung *et al.*, 2015; Padilla-MeléNdez *et al.*, 2013
MQSY 1	Setting specific times to search and find required information	**System Quality**	Sarrab *et al.*, 2015;
MQSY 2	Providing an advanced search mechanism in the application.		Sarrab *et al.*, 2015; Almaiah *et al.*, 2016
MQSY 3	Providing acceptable time to load and display the educational materials.		Sarrab *et al.*, 2015; Parsons & Ryu, 2006; Al-Mushasha & Farouq, 2008; Seddon & Kiew, 2007
MQSY 4	Providing the target audience languages in an M-learning application.		Sarrab *et al.*, 2015; Gafni, 2009; Al-Mushasha & Farouq, 2008; Seddon & Kiew, 2007; Wong, 2015

MQSY 5	Providing features to support learners with different learning needs in the application.		Parsons & Ryu, 2006; Al-Asmari & Rabb Khan, 2014; FernáNdez-LóPez *et al.*, 2013; Wong, 2015
MQSY 6	Providing content in the application free of grammatical and syntax errors.		Stockdale & Borovicka, 2006; DeLone & McLean, 2003; FernáNdez-LóPez *et al.*, 2013; Wong, 2015
MQSY 7	Providing online guidelines for finding and installing the application in any device or system.		Acharya & Sinha, 2013; FernáNdez-LóPez *et al.*, 2013
MQSE 1	Providing high quality learning and useful content in the M-learning application.	**Service Quality**	Stockdale & Borovicka, 2006; DeLone & McLean, 2003; FernáNdez-LóPez *et al.*, 2013
MQSE 2	The application is secure and confidential information stored.		Cheung *et al.*, 2015; Al-Mushasha & Farouq, 2008; Mushasha & Nassuora, 2012; FernáNdez-LóPez *et al.*, 2013
MQSE 3	Providing a mechanism for updating information periodically.		Acharya & Sinha, 2013; Almaiah *et al.*, 2016; FernáNdez-LóPez *et al.*, 2013
MQSE 4	Mobile devices and applications can easily be handled by users.		Cheung *et al.*, 2015; Mushasha & Nassuora, 2012; FernáNdez-LóPez *et al.*, 2013
MQIN 1	They are providing consistent and comfortable colours and fonts in the applications.	**Interface Quality**	Aladwani & Palvia, 2002; Al-Asmari & Rabb Khan, 2014; Duarte Filho & Barbosa, 2013; Bhuasiri *et al.*, 2012; Calisir *et al.*, 2014
MQIN 2	Providing shortcut buttons on each application screen to make the browsing easier.		Aladwani & Palvia, 2002; Al-Mushasha & Nassuora, 2012; Duarte Filho & Barbosa, 2013; Bhuasiri *et al.*, 2012; Calisir *et al.*, 2014
MQIN 3	Providing shortcuts to main functions in a special list to the application users.		Aladwani & Palvia, 2002; Al-Mushasha & Nassuora, 2012; Duarte Filho & Barbosa, 2013; Bhuasiri *et al.*, 2012; Calisir *et al.*, 2014
MQIN 4	Providing a drop-down menu for the most frequently used links.		Al-Mushasha & Nassuora, 2012; Almaiah *et al.*, 2016; Duarte Filho & Barbosa, 2013; Bhuasiri *et al.*, 2012; Calisir *et al.*, 2014

A number of researchers have used the term "service quality" in M-learning to connote the provision of high-quality service to clients, helping to gain user trust and giving fast and reliable service (Al-Mushasha & Farouq, 2008). The service quality is defined by Mushasha and Nassuora as "desires or wants of consumers, what they feel a service provider should offer rather than would offer." So, service quality includes information availability, usability, privacy, graphic style, fulfilment, accessibility, responsiveness, and personalization (Al-Mushasha & Farouq, 2008; Mushasha & Nassuora, 2012). Additionally, the interface quality relates to the information gained through M-learning applications (Badwelan *et al.*, 2017).

These quality requirements represent the fundamental aspects of IS that will be beneficial for measuring the performance and acceptance levels of M-learning systems among stakeholders (Almaiah *et al.*, 2016; Al-Mushasha & Nassuora, 2012). Table 1 identifies the quality requirements that can be measured to determine the level of customer satisfaction, which in turn helps illustrate the learning application framework measurements for this study. The application quality contained three constructs related to system quality, service quality, and interface quality. Their measurement items are, respectively, MQSY1 to MQSY7, MQSE1 to MQSE4, and MQIN1 to MQIN4.

3. Theoretical Framework

3.1 Framework of M-learning Acceptance in Saudi Arabia

The current research used the UTAUT framework as a starting point for the analysis of M-learning acceptance. Notwithstanding its benefits, however, the UTAUT framework would also benefit from being adjusted to the specific context of M-learning technologies.

3.2 Methodology and Research Process

According to the study goals and based on relevant hypotheses, it is important to ensure that the requirements identified lead to the success of M-learning applications in the target population. The positivist approach helps us study causal relationships, allowing for more comprehensive experimental studies. For example, the UTAUT model does not include the quality construct in M-learning applications, which can be divided into system quality, information quality, and service quality (Venkatesh *et al.*, 2003). Therefore, studying the causal relationship between the application's quality and BI constructs is one of the fundamental aspects of scrutiny in this study. Furthermore, demographics constitute one of the main social characteristics that impact the acceptance of M-learning applications in Saudi Arabia. Moreover, the basic requirements that consider the views of the Saudi community might help to build an appropriate model to improve the acceptance of M-learning applications in Saudi Arabia, so the positivist paradigm is particularly appropriate for our purposes. Identifying appropriate methodology helps deepen one's understanding of the research problem and provides suitable methods for developing the research question; in turn, a relevant research question helps with developing appropriate solutions to fulfil research objectives (Alise & Teddlie, 2010; Feilzer, 2010; Greene, 2007; Johnson & Onwuegbuzie, 2004; Morse, 2003). Therefore, the choice of quantitative method to obtain a deeper understanding of and more accurate results for a specific theoretical framework is essential step (Guba, 1990; Guba & Lincoln, 1998). This type of research method also helps with predicting the strengths and weaknesses of variables and determining the relationships between them.

3.3 Research Hypotheses

The hypotheses in this study are divided into two main groups. First, general hypotheses, labelled H1 to H4, test the main and official constructs of the framework. Second are the hypotheses related to new constructs that are linked to mobile application quality. These are coded H5 to H7 and are the system, service, and interface qualities. All the hypotheses combine to test the impact of the constructs on the BI of the target audience and their acceptance levels regarding M-learning.

4. Data Analysis

4.1 Survey Design and Content

The questionnaire contained questions to collect demographics and to determine potentially influential factors. The demographic information related to the participants' experiences and backgrounds, including their gender, age group, and education levels and their levels of experience as users of M-learning and the Internet. The general questions aimed to focus on interesting aspects of M-learning application requirements for the target audience (see Appendices A & B). In addition, the indicator items focused on the requirements in an M-learning application that would increase its level of acceptance and lead to an increase in the participants' intentions to regularly use M-learning applications in the future. The answers in that section were measured by a 5-point Likert scale from 5, strongly agree, to 1, strongly disagree (see Table 3).

4.2 Data Sampling

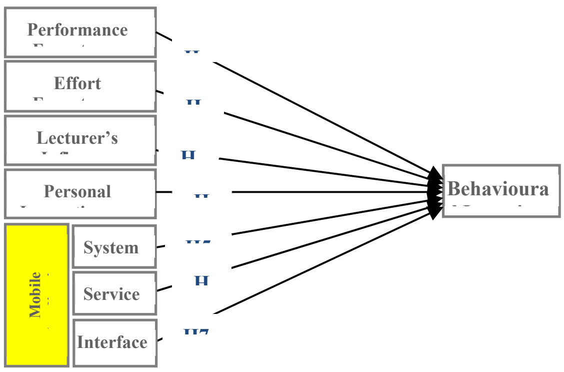

Figure 1: The UTAUT (Modified) Model for Successful M-learning Application

According to the General Authority of Statistics in the KSA, the number of higher education students in 2017 was 1.4 million enrolled in 24 Saudi government universities and nine private universities (State, 2017). Some public and private universities already offered fully online teaching tools and electronic versions of materials for courses before the COVID 19 pandemic. Students enrolled in public and private universities were the target sample for this research.

It was required that potential participants to complete the survey

Table 2: The Reliability of the Pilot Study

Name of group	Number or items	Reliability test
All	32	0.905
Performance Expectancy (PE)	6	0.738
Effort Expectancy (EE)	4	0.703
Lecturer's Influence (LI)	2	0.734
Personal Innovativeness (PInn)	2	0.916
System Quality (MQSy)	5	0.933
Service Quality (MQSe)	4	0.912
Interface Quality (MQIn)	4	0.894
Behavioural Intention (BI)	5	0.807

questionnaire had some skills and knowledge about M-learning. Therefore, three questions were used to filter participants before starting the questionnaire. These inclusion criteria were that the respondent had to have some previous experience with M-learning devices, lived in Saudi Arabia during the study period, and was enrolled in a university or non-vocational higher education facility. The sample size was calculated using the Raosoft formula based on the number of current university students at the time the study was conducted, which was 1.4 million, and the margin of error was 5.0%, with a level of confidence at 95%. The sample size was calculated to be a minimum of 385 participants (Raosoft, 2019). The number of the actual responses are 538.

4.3 Ensuring the Appropriateness of Questions for the Target Audience

Four steps were taken to ensure the questions correctly measured relevant factors and were clearly understandable. First, the questionnaire was reviewed by experts in three different field: IT, teaching, and linguistic e-learning methods. Second, the questionnaire was translated twice, from English to Arabic because the official language is Arabic, and then the Arabic version was translated back to English by an independent organization to ensure compatibility between the Arabic and English meanings and general concepts. Third, a pilot study was conducted with a sample equivalent to 10% of the official sample size, and internal consistency was calculated; the results are presented in Table 4. Finally, the questionnaire was widely distributed using the snowball technique to reach the required number of participants. The purpose of the study, including the research objectives and a definition of M-learning, was briefly presented at the top of the questionnaire.

4.4 Descriptive Research Questionnaire

The demographic part of the questionnaire comprised 11 questions that concentrated on two essential issues: the participants' characteristics and their previous knowledge of online learning. The indicator section contained questions intended to identify and measure the participants' opinions about the main requirements for increasing the acceptance levels for M-learning applications in smartphones. This section was separated into eight constructs according to the modified UTAUT model for this study.

4.5 Demographic Questions

The demographic questions were split into three groups. The first group determined the participants' basic characteristics, while the second group concentrated on the characteristics of learning through M-learning applications. The final group focused on the characteristics of working on smart M-learning devices. Any missing data should not exceed 5% (Hair *et al.*, 2006; Tabachnick & Fidell, 2007). In this study, missing data were calculated to be 3.8%, encompassing participants who failed to complete at least 90% of the questionnaire or left one or more entire sections unanswered, and these were eliminated from the study (12 participants).

4.6 Assessment of Standard Deviations and Normal Distribution

After determining the percentage of missing data, the standard deviation (SD) and normal distribution were calculated to ascertain the level of data dispersion and the distance between the mean curve and deviation trend (Field, 2005). The SD should be less than 1.0. A low SD means that values are spread over a small area of the mean curve and that a given sample size represents a target audience well. Two types of normal distribution tests are skewness and kurtosis tests (Tabachnick & Fidell, 2007). Ideally, the values derived for skewness and kurtosis should fall between 0 and 2.50+ (Hair *et al.*, 2006). In our study, the skewness and kurtosis values ranged from –2.341 to 1.943 and from –0.782 to 2.483, respectively, falling within the recommended ranges.

4.7 Reliability Scale

In the evaluation of quantitative data, a reliability test that accentuates the reliability of data and the internal consistency between constructs in a research model is essential depending on the level of the reliability test. Then, elements of the questionnaire can be kept or eliminated to ensure good consistency of results among the various elements. The appropriate minimum Cronbach's alpha value is 0.60, which was also the level adopted as acceptable in the current study (Hair *et al.*, 2006; Pallant, 2005). Table 2 presents the Cronbach's alpha values of the eight constructs under this study's UTAUT theoretical framework. The values ranged from 0.639 to 0.967, indicating good internal consistency and reliability of the questionnaire.

4.8 Exploratory Factor Analysis (EFA) and Factor Extraction and Rotation

Exploratory factor analysis (EFA) is a statistical test to determine the strength of the study's elements and the relationship between this strength and the study's main objectives (Hair *et al.*, 2006). A number of sub-tests included in the EFA are fundamental tests that help researchers build a basic model for identifying factors, implementing revisions to eliminate imperfect elements, and constructing a solid integrated model. These tests are the Kaiser–Meyer–Olkin (KMO) text, Bartlett's B test, and the eigenvalue.

The KMO test is used to determine whether a sample used in social science research is sufficient. The KMO value should be more than 68.13% for a sample tested with EFA (Field, 2005; Hutcheson & Sofroniou, 1999). In this study, the proportion of the overall population represented was 79.24%, which is considerably higher than the value projected in the statistical hypotheses.

Additionally, Bartlett's B test measures the appropriate level of correlation in EFA tests and uses statistical significance scores to indicate the results of EFA testing (Pallant, 2005). This study had a Bartlett's value of 6747.461, which was also statistically significant at the 0.001 level. Aside from the previous two tests, Tabachnick and Fidel (2007) noted the importance of the efficiency level in extracted factors and identified what appropriate constructs more strongly indicate a high degree of correlation. In the present work, principal components analysis (PCA) was used to extract factors because this method is widely employed in determining what is necessary for representing structural factors. Included with the PC A was the eigenvalue test, used to determine the suitable number of constructs in research (Pallant, 2005), which should exceed 1 (see Table 6). The eigenvalue and Cattell's scree test score indicate the number of constructs that were drawn from the literature review and how they can be aggregated with associated constructs (see Tables 5 and 6). At this stage, the total number of factors was 36, all of which satisfied the basic requirements of the EFA tests. That the factors corresponded with their constructs was confirmed; thus, the next phase involved additional tests designed to analyse internal consistency among the factors in each construct. Accordingly, a confirmatory factor analysis was conducted to further validate the model.

4.9 Confirmatory Factor Analysis

Before testing the ties between constructs and looking for significant relationships, as is done in multiple regression or correlation tests, an essential task is to evaluate the validity of factors within the constructs in a model. This evaluation is a critical test of measurement theory (Gerbing & Anderson, 1988; Hair *et al.*, 2006). Assessing the validity of constructs is one of the recent key approaches to data analysis. For this reason, after the internal consistency and reliability tests were conducted, CFA was carried out to test the theoretical framework of the present study. One of the core advantages of CFA, which can be defined as a subset of structural equation modelling (SEM), is that it generates a more rigorous interpretation than those derived through the previously implemented EFA tests (DiStefano & Hess, 2005; Hair *et al.*, 2006). CFA was conducted primarily because this method is typically used to enhance the overall shape of a model by examining relationships and using them to produce the best procedure for designing a model. CFA also focuses on testing existing dimensional structures. EFA was carried out because it enables a preliminary verification of the fundamental constructs of each model on the basis of factors extracted from a study (DiStefano & Hess, 2005). CFA strengthens EFA and refines and supports a conceptual framework. This section includes a discussion of the analysis of the structure of factors in each construct of this study's theoretical framework.

4.10 Assessment of Model Fit and Estimation Methods

When testing a research model via CFA, numerous results advance the measurement of model acceptance or rejection levels. Good indicators mean that the data are of favourable quality and confirm the validity of a theoretical framework, while unsatisfactory indicators reveal the need to improve and re-test a theoretical framework before acceptance can be achieved. The indicators and ideal values for each of the tests conducted in this work are presented in Table 7.

4.11 Measurement Model

The statistical tests at this stage represented the validity and reliability of the SEM, which was used to evaluate the relationships between the constructs in the theoretical framework. This section focuses on the SEM-related statistical tests and specific measurement criteria that served as the evaluation factors related to M-learning applications in smartphones. Thus, SEM was directed primarily towards testing the validity of the theoretical framework by examining and evaluating the linear relationships between the constructs to understand the power of the relationships and then test the hypotheses. These tasks are helpful in plans for using the theoretical framework in a similar study in the future (Shah & Goldstein, 2006). After measuring the relationships between the factors and constructs in the theoretical framework, these elements were validated to confirm that internal measurements were accurately calculated.

In statistics, the composite reliability (CR) scale and average variance extracted (AVE) are the most accurate tests of reliability and variance between factors. They can be used to deal with complex constructs in advance and accordingly address the reliability of the constructs and related precursors (Koufteros, 1999). A reliability test does not have a standard form in statistical programs. An acceptable CR value is 0.6 or more (Bagozzi & Yi, 1988), and the recommended AVE value is 0.5 or more for a variable to satisfactorily represent a construct (Hair *et al.*, 2006), where AVE is the sum of squared standardized loadings of the total number of items.

Table 3: Frequency of Responses for Examined Means, SDs, Skewness, and Kurtosis

Factor Code	*Mean*	*SD*	*Skew*	*Kurtosis*	*Cronbach's alpha*	*CR*	*AVE*	*Rotated Factor Loadings*
PE1	4.48	0.663	-1.823	2.451	0.919	0.8674	0.6327	0.691
PE2	4.65	0.750	-2.114	2.408				0.585
PE3	4.36	0.752	-1.49	2.077				0.587
PE4	4.33	0.737	-1.515	2.08				0.607
PE5	4.43	0.696	-1.691	2.282				0.662
PE6	4.67	0.694	-2.078	2.296				0.664
EE1	4.46	0.682	-1.806	2.063	0.790	0.8495	0.676	0.694
EE2	4.74	0.634	-2.237	2.052				0.680
EE3	4.70	0.698	-2.328	2.247				0.649
EE4	4.29	0.810	-1.087	1.418				0.681
LI1	4.37	0.771	-1.332	2.324	0.491	0.6991	0.6435	0.738
LI2	3.65	1.043	-0.412	-0.782				0.549
PLNN1	4.14	0.788	1.038	1.941	0.639	0.7842	0.733	0.717
PLNN2	4.40	0.769	1.651	2.346				0.755
MQSY1	4.37	0.822	1.378	2.071	0.929	0.9312	0.7266	0.624
MQSY2	4.50	0.753	1.751	2.427				0.730
MQSY3	4.46	0.760	1.943	2.127				0.722
MQSY4	4.60	0.754	-2.035	2.288				0.744
MQSY5	4.53	0.719	-2.277	2.338				0.718
MQSY6	4.60	0.672	-2.309	2.17				0.766
MQSY7	4.64	0.647	-2.106	2.356				0.782
MQSE1	4.65	0.683	-2.105	2.008	0.849	0.8705	0.7045	0.806
MQSE2	4.59	0.707	-1.213	2.453				0.811
MQSE3	4.64	0.647	-1.587	2.456				0.824
MQSE4	4.65	0.683	-1.464	1.923				0.806
MQIN1	4.56	0.678	-2.204	2.483	0.891	0.8237	0.7555	0.821
MQIN2	4.31	0.761	-2.341	2.342				0.703
MQIN3	4.39	0.774	-2.204	2.220				0.654
MQIN4	4.39	0.728	-1.729	2.364				0.698
BI1	4.07	0.989	-1.033	0.391	0.941	0.8964	0.7092	0.504
BI2	4.21	0.846	-1.122	1.636				0.771
BI3	4.23	0.876	-1.249	1.551				0.754
BI4	4.22	0.896	1.5	2.328				0.763
BI5	4.48	0.663	-1.823	2.451				0.754

Table 4: Total Variance Explained

Component	Initial Eigenvalues			Extracted Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	17.267	47.965	47.965	17.267	47.965	47.965	7.829	21.748	21.748
2	3.568	9.910	57.875	3.568	9.910	57.875	5.009	13.913	35.662
3	2.453	6.813	64.687	2.453	6.813	64.687	3.325	9.237	44.899
4	1.493	4.148	68.836	1.493	4.148	68.836	3.068	8.522	53.422
5	1.331	3.696	72.532	1.331	3.696	72.532	3.066	8.516	61.938
6	1.117	3.103	75.634	1.117	3.103	75.634	2.399	6.663	68.601
7	1.022	2.838	78.472	1.022	2.838	78.472	2.013	5.592	74.193
8	**0.787**	**2.186**	**80.659**	**0.787**	**2.186**	**80.659**	**1.817**	**5.047**	**79.240**
9	0.755	2.099	82.757						
10	0.670	1.860	84.617						
Note: Extraction method – PCA – Eight components extracted									

Table 5: Correlation Matrix and Discriminant Validity of the Measurement Model + Path Coefficients, t-values and p-values of the Hypotheses

Relationship or Path	PE	EE	LI	PInn	MQSY	MQSE	MQIN	BI	Hypothesis No.	Estimate	t-value (R^2)	Path	p-value
PE	**0.796**								H1	0.691	11.283	PE → BI	***
EE	.592**	**0.823**							H2	0.675	6.650	EE → BI	***
LI	.275**	.532**	**0.803**						H3	0.938	7.977	LI → BI	***
Plnn	.302**	.548**	.651**	**0.847**					H4	0.873	4.916	Plnn → BI	***
MQSY	.182**	.418**	.198**	.477**	**0.853**				H5	0.765	10.961	MQSY → BI	***
MQSE	.139**	.425**	.201**	.419**	.701**	**0.870**			H6	0.652	13.017	MQSE → BI	***
MQIN	.159**	.480**	.394**	.538**	.643**	.684**	**0.84**		H7	0.730	8.610	MQIN → BI	***
BI	.303**	.460 **	.618**	.736**	.523**	.416**	.515**	**0.843**					

Fornell and Larcker (1981) asserted that the AVE test should be used to measure discriminant validity and compress the square roots of the constructs in a model. The square root of each construct should be larger than the values of other constructs. The relevant values, which are indicated in dark blue highlighting beside each construct in Table 7, demonstrate that the constructs in this study were closely related. Finally, the relationships between the constructs were measured via three tests: t-value, p-value, and standardized regression coefficient. The previously conducted tests (CFA and measurement model tests) were performed to identify the weaknesses of the hypotheses formulated for this study. The p-values of H1 to H7 were between 0.749 and 0.531 and were statistically significant at the 0.001 level. The R^2 ranged from 10.905 to 7.069, exceeding the recommended value of 1.96. The values shown in Table 7 indicate that all the tested factors satisfied the acceptability standards of the coefficient structure model; this is one of the SEM requirements. The results of the entire construct indicated positive effects on the BI of a user to adopt M-learning applications using smartphones (see Table 7).

4.12 Testing the Nomological Validity of the Measurement Model

One of the most powerful methods of validating a theoretical model is testing nomological validity (Bagozzi, 1980; Cronbach, 1971), which focuses on the correlation of statistical values with conceptual procedural methods to ensure the validity of a study's theoretical framework (Hair *et al.*, 2006). Nomological validity also reflects the size of predictions about factors that influence an original model (Straub *et al.*, 1995). In this study, nomological assessment was directed particularly towards the activation and spread of acceptance factors for M-learning applications in Saudi universities using goodness-of-fit indicators. The SEM approach was implemented because the objective of the evaluation was to test the strength of the convergence, differentiation, and credibility of nomological factors that influence the acceptance of M-learning through smartphones. The validity of the requirements standardized in the framework was important in measuring the prerequisites for such acceptance among university students in Saudi Arabia.

In this study, a model of requirements for technological acceptance was developed, and its nomological validity was tested. Also tested were the relationships between the constructs that help increase the acceptance of electronic systems on the basis of constructs in the UTAUT framework and newly established constructs, which were employed primarily to determine the technical and learning requirements affecting the acceptance and use of smartphone M-learning applications. The hypotheses were divided into two groups. The first group, H1 to H7, revolved mainly around testing the theoretical model and the convergence between the related constructs in the model that are tested in this study.

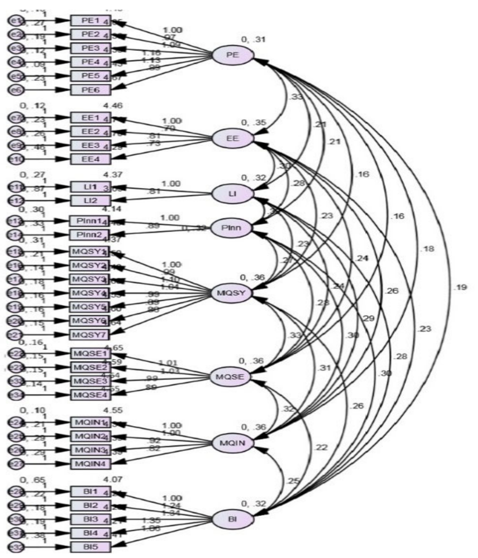

Figure 2: Model Constructs Tested via CFA

5. Discussion

An empirical study based on the UTAUT framework for mobile learning applications was carried out through many quantitative tests to effectively shed light on the research issues pursued in this work. Those are examining the basic constructs of UTAUT and their relevant relationships to BI and increasing the acceptance level and use of M-learning, which depends on the unique requirements of Saudi society and, therefore, need to be identified.

5.1 Performance Expectancy

This study's H1 was supported, and a significant relationship was shown from the responses between PE and BI. A good relationship in H1 is beneficial for the expected performance of students because it helps them increase their awareness of M-learning innovations through a focus on their usefulness, how these technologies are activated, and their on-demand availability. The recognition of these features is also facilitated through the evidence presented in this study.

In other words, PE is a key aspect for consideration when evaluating which of the features and benefits of M-learning applications are the most important for increasing acceptance of these technologies (Alshehri, 2012; Badwelan *et al.*, 2016). Increasing acceptance will pave the way for extensive use of mobile educational applications (Abu-Al-Aish & Love, 2013; Cheung *et al.*, 2015). A high percentage of the respondents stated that an essential attribute of M-learning applications is an underlying foundation of specific objectives (PE01). An important goal, therefore, is to understand the purpose of each application, what objectives the application covers, and the benefits that can be expected from its use on the basis of a variety of criteria (Cheung *et al.*, 2015; Padilla-Meléndez *et al.*, 2013; Wang *et al.*, 2009). Examples of these criteria include whether the vision and mission of an application is clearly articulated, whether the covered learning objectives are identified, and how these objectives can be measured from the beginning to the end of usage.

In the meantime, the allowance to use M-learning applications and save time and effort is a good motivation to distribute M-learning applications and increase the opportunities to use them widely. Thus, it is beneficial to increase student acceptance of mobile learning innovations and proficiency in using them (Abu-Al-Aish & Love, 2013; Cheung *et al.*, 2015). A related aspect identified was that the time and effort reduction enabled by M-learning applications increases productivity opportunities, which represents one of the strongest motivations for adopting online learning through applications. This feature is vital, as smart mobile users account for more than 75% of the total number of mobile users in the entire KSA to date (Aitnews, 2017). In addition to the allowance to use M-learning applications, it is important to provide live channels, which can be beneficial in that they help users directly find solutions to problems that are more difficult to absorb during the learning process (Al-Adwan *et al.*, 2013). According to high-context communication theory, people in Saudi Arabia prefer time-saving ways to communicate with technical support live, in real time, to solve their issues and difficulties when working in online channels (Alshehri, 2012; Bahaddad *et al.*, 2017; Würtz, 2005). Also, several social media applications can be implemented in M-learning apps to provide live chat functionality, which can ease and hasten learning (Chong *et al.*, 2011; Gikas & Grant, 2013). In line with this, up to 90% of the participants of this study believe in the importance of providing a live chat indicator as a component of M-learning applications, which may give rise to appropriate learning environments or gradually improve existing ones (PE05) (Cheung *et al.*, 2015; Padilla-Meléndez *et al.*, 2013).

Moreover, the incorporation of educational objectives is necessary for online learners to successfully accomplish assigned tasks (PE06) (Wang *et al.*, 2009). Grounding an M-learning course in specific objectives will allow for the provision of scientific materials that serve learning goals or objectives. These objectives will also augment productivity and achievement as an initial advantage and eventually produce other benefits for potential users of M-learning applications (Al-Adwan *et al.*, 2013; Cheung *et al.*, 2015).

5.2 Effort Expectancy

Cognition and knowledge of M-learning applications can be determined by several factors that are intended to identify EE and its importance for the target population (i.e., Saudi university students). The general theoretical framework indicates a significant relationship between EE and BI. These results confirm that ease of use is one of the factors that influences increasing acceptance of M-learning applications. However, it should be noted that M-learning applications may end up requiring a greater level of effort than that needed in the operation of traditional and old-fashioned methods of learning (Arkorful & Abaidoo, 2015; Barrette, 2015). A suitable EE should thus be guaranteed in M-learning applications to increase acceptance (Al-Bakr *et al.*, 2017; Al Gamdi & Samarji, 2016). The relevant aspects indicated in the data are flexibility through the quality of the provided M-learning services; the simplicity of using the applications; technical tools that facilitate online learning tasks, such as discussions through multimedia content and live chat sessions; and detailed clarifications of the steps required to operate the technical tools that accompany electronic applications (Barrette, 2015). A majority of participants indicated their agreement with the importance of these factors. Additionally, there was agreement on the importance of the ease of use through the applications' multimedia content, including explaining and clarifying many of the organizational aspects needed by users and that educational issues and learning concepts featured in an application require exposition through multimedia content (Algarni, 2014; Binyamin, 2017). In addition, understandable instructions and appropriate definitions for each tool, service, or lesson are considered to be essential factors for enabling users to effectively interact with M-learning applications, which should be equipped with a library of sufficient instructions that clear the way for spreading the adoption of online learning through mobile applications. These features should be presented to end users through transmitted messages that encourage them to take advantage of components that support M-learning applications.

5.3 Lecturer's Influence

The influence of lecturers on students stems from the confidence and trust of learners that their lecturers and any online learning activities will help them augment their ability to deal with M-learning systems, regardless of whether the benefits and advantages of these innovations are motivational (Binyamin *et al.*, 2017; Padilla-Meléndez *et al.*, 2013). The use of M-learning applications is a personal decision that can directly hinge on self-satisfaction and online learning teams or experienced users. In this study, therefore, an essential LI-related requirement was the provision of feedback by university teachers regarding students' use of the M-learning applications and reviews of the advantages and utility of M-learning applications for students (Abbad & Jaber, 2014; Binyamin *et al.*, 2017; Fernández-López *et al.*, 2013). For this reason, communication channels are necessary so that academic and technical teams can inform users about the satisfaction they may experience using M-learning features and how they can handle applications with assistance from technical and academic teams (Abbad & Jaber, 2014).

5.4 Personal Innovation

The quantitative findings of this study are in alignment with an information revolution in Saudi Arabia led by the government over the last five years through its 2030 Vision, a relevant digital transformation that should be accomplished by 2020, and the repercussions of the COVID-19 pandemic (NTP, 2017). This movement will lead to resolving any outstanding issues that significantly influence the motivation of university students to adopt M-learning applications without reservations.

One of these outstanding issues is the establishment of a professional infrastructure for an integrated portal between relevant bodies for the purpose of achieving considerable improvement in online learning and educational e-resources (Cheung *et al.*, 2015; Iqbal & Qureshi, 2012; Padilla-Meléndez *et al.*, 2013). Examples of such portals include the Shams e-platform of the MOE, the DROP e-platform of the Ministry of Labour and Social Service (Shams, 2018; Doroob, 2018), and the Madrasati platform, which was approved after suspending students' attendance at schools by the Saudi MOE (Madrasati, 2020). These platforms are designed to provide a variety of suitable e-resources for target users to obtain the information and skills necessary for developing knowledge and facilitating advancement.

Other essential PInn requirements for the creation of suitable platforms are a fast and effective Internet connection, access to information sources, a mechanism for verifying and validating existing information, technical and logistical support services for problems faced by target users, and any other services or technological tools that effectively assist end users (Doroob, 2018; Madrasati, 2020; Shams, 2018). These services or technological tools may increase the motivation and ability to use electronic applications, in general, and M-learning applications, in particular.

The availability of online learning resources is especially useful in efforts to increase motivation and, thus, the acceptance and use of M-learning applications (PInn02) (Cheung *et al.*, 2015; Padilla-Meléndez *et al.*, 2013). A necessary step, then, is to develop electronic avenues that are related to M-learning applications and beneficial for increasing the motivation to employ smartphones for online learning. The development should also cover the technical aspects and human resources needed to foster and elevate M-learning acceptance.

5.5 Mobile quality (MQSY—MQSE—MQIN)

Quality is a multidimensional concept that was classified in this study into three categories: interface quality, service quality, and system quality. These three represent the aspects of quality that increase the acceptance and favourable handling of M-learning applications.

System quality is crucial for ensuring a system's stability and capacity to handle the demands of users, mainly because such demands account for the largest proportion of requirements that a system is supposed to satisfy. Correspondingly, the main contribution of this study is the development of standards for the creation of an internal system structure based on numerous criteria. These criteria focus on the automation of internal components of the system as well as on the smoothing and easing of the manner in which the best learning advantages are achieved (Bahaddad, 2017).

M-learning applications are operated for various purposes, such as searches within an application framework in a particular time frame within which an individual uses an application with high performance and efficiency to get professional results (Sarrab *et al.*, 2015). These functions can also include searching and obtaining information according to the sources made available by an application or other educational and learning platforms (Almaiah *et al.*, 2016; Sarrab *et al.*, 2015). Establishing a specific time allotment for downloading and identifying inefficient mechanisms for the search process are important to avoid the importing of large quantities of sources that are unrelated to the main search process (Bahaddad, 2017). Many of the results of search engines are generated only because of similarities in keywords, thereby negatively affecting the performance of an application in the long term (Sarrab *et al.*, 2015).

Furthermore, an inefficient process for resource searches may include the search for high-quality and low-capacity educational materials that use up a substantial amount of download and display time (Al-Mushasha & Farouq, 2008; Sarrab *et al.*, 2015; Seddon & Kiew, 2007). Language options should be available in applications to increase usability by providing interpretations for core vocabulary or translations of texts (Sarrab *et al.*, 2015; Wong, 2015). The support and features necessary to address special educational needs should be incorporated, including those for deaf and blind learners, to provide alternative learning materials suited to the requirements of these populations. Equally vital components are features that keep pace with the needs of target users and support opportunities for professional communication with these users (Al-Asmari & Rabb Khan, 2014; Fernández-López *et al.*, 2013; Wong, 2015).

The text in applications should be free of linguistic and spelling mistakes, which is an aspect that can be ensured through the incorporation of a spell checker and a mechanism for correcting errors within an application (Fernández-López *et al.*, 2013; Wong, 2015). Finally, the availability of M-learning applications in basic platforms, such as Google Play and the Apple Store, will guarantee ease of installation (Acharya & Sinha, 2013; Fernández-López *et al.*, 2013). The main findings of this and previous studies are compatible with those derived by earlier pilot studies on system quality or the diversification of information resources via smart devices.

Service quality adds value to applications through facilitating e-services in the M-application and therefore plays a central role in increased acceptance and usage. Thus, applications should incorporate high-quality and well-developed content to increase the favourable reception and usage of it by a target segment (Almaiah *et al.*, 2016). Another requirement related to service quality is trust, which is a goal that is achieved in the long term through specific electronic application frameworks based on a range of criteria, such as confidentiality of personal information and backup tools for easily saving and transmitting information to other devices. Once trust and confidence in M-learning applications are achieved, acceptance and adoption will accordingly increase, which makes M-learning reuse more frequent over time (Cheung *et al.*, 2015). Additionally, the mechanism for updating information must be executed automatically without human intervention (an automation that can be enabled with various search engines and information sources that help feed scientific materials into applications), and artificial intelligence must be in place to support updates (Almaiah *et al.*, 2016).

Furthermore, M-learning applications that are easy to use are characterized by a number of features, including the display of no more than one function onscreen; the provision of sufficient information about each service in an application, including how to use it; and the activation and deactivation of a service on the basis of user information or user location (Cheung *et al.*, 2015). The requirements that are needed by women could differ from those of men, and the requirements of a user located in a quiet zone vary from those of a user in a noisy environment (Al-Bakr *et al.*, 2017), which will be implemented in future research plans. Therefore, providing flexible enable and disable functions might help to make the application more convenient for end users, which might lead in turn to increasing the target audience's acceptance level (Bahaddad, 2017). The results with respect to service quality were partly discussed in several diverse studies on the quality of electronic applications, and some previously described contributions can be applied in the context of the current research.

Finally, interface quality requires developers to consider the important needs of a target segment in the design of applications, and this consideration can be carried out through personification. The creation of personas is a new technique that involves using the perspectives and needs of target users as a basis for determining the essential criteria for the design of interfaces (Almaiah *et al.*, 2016). Persona-based standards underscore the importance of consistency between, for instance, colours and fonts in electronic applications, including M-learning applications (Al-Asmari & Rabb Khan, 2014; Calisir *et al.*, 2014). The application buttons most frequently used by a particular user should be identified, and then these buttons should be incorporated onscreen for flexibility and quick access to frequently employed functions and services (Calisir *et al.*, 2014). Another essential interface feature is the necessary authorization-related shortcuts on screens and function pages rather than multiple drop-down menus, which often cover part of the screen (Calisir *et al.*, 2014). Finally, users should be afforded the possibility of designing functions and service shortcuts that can be added to drop-down lists of frequently used items to facilitate the use of M-learning applications (Almaiah *et al.*, 2016). These results regarding interface quality extend previous experimental studies in similar or convergent fields, specifically with respect to identifying interface quality requirements for M-learning applications in smart devices.

Related to M-learning acceptance requirements are requirements for quality standards, how these affect the use of applications and what advantages they offer to universities and academic institutions in Saudi Arabia. Several factors and variables that affect the increased acceptance of M-learning applications have been listed in a number of previous studies (Almaiah *et al.*, 2016; Cheung *et al.*, 2015; Sarrab *et al.*, 2015; Wong, 2015). Almaiah *et al.* (2016), for instance, probed into the quality requirements for educational applications in Saudi Arabia and concluded that these needs are important for increasing the acceptance of smartphone applications. Cheung *et al.* (2015) noted that the creation of smartphone applications in developing countries suffers from many challenges that adversely affect the satisfaction of target users. These difficulties include the lack of interfaces that suit users' expectations, the incorporation of search engines in applications that fall short of users' expectations regarding information sources in the information space, and the presence of deficient procedures for data flow within electronic applications.

6. Implications

In this study, quality requirements represent independent constructs that were added as UTAUT variables to determine the effects of quality on increasing the acceptance of M-learning applications. That is, performance and actual requirements were measured on the basis of several principles that cover those on system, service, and interface quality. These three categories implicitly encompass accessibility and availability, which are facets that current studies experimentally investigate to identify the requirements for target user acceptance. The study also pointed out that quality standards have a positive and statistically significant effect on the BI to use educational applications on smart devices. The relationship between MQ and BI was accorded a score higher than 0.73 in the standardized regression weighting (see Table 7), thus confirming the importance of fulfilling MQ requirements in accordance with specific and clearly articulated criteria in the professional design of M-learning applications. Thus, quality standards significantly affect M-learning acceptance among Saudi university students, as well as their satisfaction and use of such applications.

Increasing the acceptance of M-learning applications necessitates finding adequate and considerable solutions for many problems, and the existence of deficiencies is one of the factors that discourage the use of online learning applications (Dhaheri & Ezziane, 2015). Another such problem is the formulation of standards for the development of application interfaces that effectively attract users. These standards can include the provision of libraries to enable users to change colours and interfaces periodically or on demand (Parsazadeh *et al.*, 2018).

Some issues related to user interfaces concern the communication between users and technical or academic teams; the response time of electronic applications; search mechanisms for high-quality learning resources that entail minimal download time and review by a user; a mechanism for presenting and verifying information before uploading it onto an application; and the system quality requirements that were previously discussed. Accordingly, the high quality of electronic application systems, ideal designs of application interfaces, identification of best practices in defining application features, and the provision of instructions for how to use these innovations may be favourable solutions to existing problems and may increase the acceptance of and satisfaction with M-learning applications (Parsazadeh *et al.*, 2018). Certain studies have delved into and implemented user acceptance requirements in various online application systems and e-service, e-payment, and e-governance platforms, with a focus on the importance of quality and its effects on BI, actual use, and user satisfaction (e.g., Parsazadeh *et al.*, 2018; Sarrab *et al.*, 2015).

Finally, the positive results with respect to quality requirements reflect the importance of successfully finding common ground between online learning and other electronic applications and the fact that satisfying these requirements will translate to adequate support for external and independent requirements for increasing the acceptance of learning applications on the basis of the UTAUT framework (Almaiah *et al.*, 2016). This common ground should include what the smart device applications, including M-learning applications, should contain to be acceptable in Arabic societies, in general, and among university students, in particular.

7. Conclusion

This study focused on identifying the M-learning requirements for increasing the level of acceptance in higher education communities at university and academic institutions in the KSA. This paper presented answers to the research questions pursued in this work, after which the research contributions to theory, methodology, and practice were described. The limitations were also presented, along with a discussion of how these deficiencies can serve as directions for future research and guidance for addressing gaps in the literature. This study was implemented in a relatively new and advanced field, and the results may be useful in terms of adding to the quality of a number of areas of M-learning, such as M-government or M-services, which can be activated in certain for-profit sectors, non-profit government entities, and private enterprises inside and outside Saudi Arabia.

8. List of References

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Appendix A

Table 6: Results of Demographic Questions (N = 539)

1 - Gender			**7 - Frequency of Online Service Usage for Learning**		
Male	289	53.62	1 time per week	42	7.79
Female	249	46.2	1-5 times per day	199	36.92
Missing	1	0.19	5-10 times per day	139	25.79
2 - Age Group			More than 10	40	7.42
18 Years or Less	12	2.23	1 time per week	117	21.71
19 – 20	38	7.05	Missing	2	0.37
21 – 22	92	17.07	**8 - Internet Plan**		
23 – 24	105	19.48	Mobile post-paid SIM with Internet service	279	51.76
25 – 26	93	17.25	Prepaid SIM card with Internet service	12	2.23
27 – 28	67	12.43	Data SIM card	83	15.4
29 – 30	61	11.32	DSL	165	30.61
31 Years or More	66	12.24	Missing	0	0
Missing	5	0.93	**9 - Type of Internet Service Providers (ISPs)**		
3 - Level of Education			Wi-Fi	73	13.54
Undergraduate	70	12.99	3G	322	59.74
Graduate	221	41	4G	136	25.23
Master	202	37.48	Missing	8	1.48
PhD	41	7.61	**10 - Kind of Smartphone Used (Multiple Answers Possible)**		
Missing	5	0.93	Smartphone	373	69.2
4 - Experience with Smartphones			Tablet/ iPad	73	13.54
Less than 1 year	22	4.08	Ultra laptop	84	15.58
1-2 Years	86	15.96	PDA/palmtop	9	1.67
3-4 Years	229	42.49	Missing	0	0
5 years or more	195	36.18	**11- Preferred Device for Use in M-Learning (Multiple Answers Possible)**		
Missing	7	1.3	Smartphone	501	92.95
5 - Level of E-learning Knowledge			Tablet/ iPad	365	67.72
Moderate	57	10.58	Ultra laptop	428	79.41
Good	183	33.95	PDA/palmtop	227	42.12
Very good	224	41.56	Missing	3	0.56
Nothing	74	13.73			
Missing	1	0.19			
6 - Extent of Willingness to Use M-learning Applications					
High	252	46.75			
Medium	53	9.8			
Low	233	43.22			
Missing	1	0.19			

Appendix B

TABLE 7: FREQUENCY OF RESPONSES OF EXAMINED QUESTIONS AND THEIR MEANS, SDS, AND SKEWNESS AND KURTOSIS VALUES

CODE	Mean	SD	Skew	Kurt	SDA	DA	N	A	SA	M	**Code**	Mean	SD	Skew	Kurt	SDA	DA	N	A	SA	M
PE1	4.48	0.663	-1.823	2.451	6	0	15	227	291	0	**PLNN1**	4.14	0.788	1.038	1.941	6	91	110	204	120	8
PE2	4.65	0.750	-2.114	2.408	6	16	10	84	439	0	**PLNN2**	4.40	0.769	1.651	2.346	6	10	69	268	178	8
PE3	4.36	0.752	-1.49	2.077	6	10	24	87	412	0	**MQSY1**	4.37	0.822	1.378	2.071	6	10	56	279	180	8
PE4	4.33	0.737	-1.515	2.08	6	6	36	231	260	0	**MQSY2**	4.50	0.753	1.751	2.427	6	5	60	167	293	8
PE5	4.43	0.696	-1.691	2.282	6	8	26	259	240	0	**MQSY3**	4.46	0.760	1.943	2.127	6	0	54	142	329	8
PE6	4.67	0.694	-2.078	2.296	1.1	.4	4.1	231	278	0	**MQSY4**	4.60	0.754	-2.035	2.288	6	13	12	201	299	8
EE1	4.46	0.682	-1.806	2.063	6	8	10	109	406	0	**MQSY5**	4.53	0.719	-2.277	2.338	11	3	12	134	371	8
EE2	4.74	0.634	-2.237	2.052	6	2	16	228	287	0	**MQSY6**	4.60	0.672	-2.309	2.17	9	0	17	183	322	8
EE3	4.70	0.698	-2.328	2.247	6	1	20	77	436	0	**MQSY7**	4.64	0.647	-2.106	2.356	6	0	20	153	352	8
EE4	4.29	0.810	-1.087	1.418	6	6	20	82	425	0	**MQSE1**	4.65	0.683	-2.105	2.008	6	5	12	124	384	8
LI1	4.37	0.771	-1.332	2.324	25	6	83	176	249	0	**MQSE2**	4.59	0.707	-1.213	2.453	6	5	17	146	357	8
LI2	3.65	1.043	-0.412	-0.782	9	6	52	195	277	0	**MQSE3**	4.64	0.647	-1.587	2.456	6	14	137	374	531	8
BI1	4.07	0.989	-1.033	0.391	6	0	36	225	264	8	**MQSE4**	4.65	0.683	-1.464	1.923	6	5	12	124	384	8
BI2	4.21	0.846	-1.122	1.636	6	52	50	214	209	8	**MQIN1**	4.56	0.678	-2.204	2.483	6	0	20	172	333	8
BI3	4.23	0.876	-1.249	1.551	8	6	85	205	227	8	**MQIN2**	4.31	0.761	-2.341	2.342	6	0	60	220	243	8
BI4	4.22	0.896	1.5	2.328	6	22	54	209	240	8	**MQIN3**	4.39	0.774	-2.204	2.220	6	8	35	206	276	8
BI5	4.48	0.663	-1.823	2.451	14	8	53	229	227	8	**MQIN4**	4.39	0.728	-1.729	2.364	6	0	41	217	267	8

SDA = STRONGLY DISAGREE – DA = DISAGREE – N = NEITHER AGREE NOR DISAGREE – A = AGREE – SA = STRONGLY AGREE – M = MISSING