

Determine the Main Target Audience Characteristics in M-learning Applications in Saudi Arabian University Communities

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Abstract—In the fourth economic revolution, which is based on digital transformation, the e-learning process represents one of the most important processes needed to deal with the revolution through increased skills and knowledge. Thus, the automation services in the e-learning field represent one of the most important and supportive means of transferring and disseminating knowledge to reach a diverse and wide segment. This study focuses on defining the parameters and characteristics of the target audience, who are interested in the e-learning method, through smart device applications in higher education institutions in Saudi Arabia. The study used a quantitative method and data collected from 539 participants from several universities and institutes to determine their characteristics. The study segment represents one of the basic aspects of and full motivations for accepting new technology; 70% of Saudi smart device users form the youth segment, which is the university age group. This is the category that is expected to have the most use of e-learning in light of the coronavirus pandemic, which has cast a shadow over the six continents of the world. This approach could help the adoption of M-learning applications by the target audience according to a number of technical and design requirements, which are presented in this study.

Keywords—M-learning; mobile learning; UTAUT; KSA; MOE; application quality; qualitative study

I. INTRODUCTION

E-learning represents one of the main and most important channels in the process of digital transformation, which has begun to mature in many continents and countries where e-learning represents one of the channels that helps in spreading knowledge among the various segments of society. This online process has had a great impact on the completion of the educational life march in schools and universities during the spread of the coronavirus pandemic during 2020. Through this approach, many entities were able to adopt digital transformation as a means to reduce the gap between reality and expectations during this pandemic. Many economic, commercial, and health purposes have been able to adopt digital transformation as one of the methods for reducing the impact of this pandemic that has resulted from social distancing, which is considered one of the best means of reducing the spread of the virus in societies.

There are shortfalls to be addressed in the quality of education and its opportunities for Saudi communities that require a high level of privacy and the separation of genders in

education [1],[2]. According to the MOE policy in Saudi Arabia, gender segregation in education reflects the country's religious and traditional values as well as the national policy in general [3]. It is important to consider strengthening mobile learning (M-learning) approaches by determining the requirements that produce acceptable M-learning application designs for students in Saudi universities. In the meantime, more than 75% of mobile subscribers in Saudi Arabia are already using smartphone devices for most of their daily life purposes [4]. Thus, there are several opportunities that would help the target audience to more readily accept learning applications in this community. Further, the community can expand their knowledge while still maintaining the government policy associated with religious values.

Thus, M-learning applications have several requirements in their design to be more compatible and acceptable for Saudi communities. These applications would be required to promote an education policy in Saudi Arabia that is based on the separation of genders at all levels of education; at a distance, males and females can digitally exchange and share their information easily without breaking the religious restrictions of the Saudi society. Many previous studies have focused on the factors influencing M-learning's acceptance in the Kingdom of Saudi Arabia (KSA); however, there is a shortage of information concerning the main practical requirements related to particular societal or traditional elements related to the KSA community background as well as the community characteristics that could help and use the M-learning approach through the digital transformation revolution. These characteristics help to assign the main personas interested in using M-learning applications intensively, which could help with the professional application function design and analyses of the M-learning application systems in order to assess whether they are suitable and well-developed for students in higher education institutions in KSA.

Also, the policy of gender segregation in education in the KSA limits women's opportunities to fully develop their capabilities and skills, especially due to the restrictions regarding women that are based on religious values in Saudi Arabia [5]. These restrictions not only affect the flexibility of learning through the same channels provided for men but also do not allow for women to learn similar courses that would encourage them to use their knowledge with the same gender

in the future [5],[6]. Some examples include restrictions around driving a car, the lack of public transportation infrastructure, and the prevention of women from traveling without permission from a male relative, such as a husband, father, or brother [7]. Some of these issues have been resolved in the last two years, but their residual influence on the Saudi community means changes will take more time to be adopted. These examples of the disparity in access to mobility have given men more chances and flexibility while delaying the same for women in KSA. These reasons lead to limitations for women in opportunities to learn similarly to men in KSA. Furthermore, many of the academic disciplines that were established recently for female students, such as industrial environmental engineering, have been available to male students for more than two decades due to several traditional considerations. However, the majority of faculty members are male, which makes learning these sciences an obstacle for female students because of the same considerations of gender segregation in the various stages of education. This affects the learning process between male teachers and female students.

This research may help students accept the potential value of an M-learning environment as a way to increase the knowledge, skills, and information sharing for the target audience and, in fact, for all potential user communities. Therefore, the expected output of this research is to determine the target audience's characteristics through M-learning as an acceptable theoretical framework to enhance their learning opportunities. The main purpose for choosing the student segment is to search for new sources for exchanging knowledge outside the formal distance-learning platform of the universities. The universities' distance learning is sponsored by the KSA government and depends on the foundations of current education policies in Saudi Arabia. Therefore, M-learning applications could be helpful for students to increase their knowledge about the subjects related to universities' courses and many other learning aspects they are interested in.

The research question is, "From an end user's perspective, what are the requirements for the acceptance of mobile learning technology for smart devices at higher education institutions in Saudi Arabia?" The end users are students studying in universities or academic institutes. In addition, this research focuses on the technological and traditional requirements needed that are important to the target audience and that will increase the acceptance level. There are sub-questions that are helpful in conducting deeper research related to the main question, specifically: How do gender, experience, and willingness influence the acceptance and use of M-learning applications in KSA? The main question identifies the importance of requirements in Saudi society, which are helpful to design the requirements for this particular society. How can these requirements be explained to increase the level of acceptance of M-learning applications for students in Saudi universities? The sub-question focuses on the unique features related to societal characteristics such as those for gender, experience, and willingness, and their influence on the level of acceptance for using M-learning applications in university students in KSA.

The research structure is divided into several parts, which are the literature review, theoretical framework, research methodology, analysis of quantitative data, discussion of results, and the implications and recommendations.

A. M-learning Definition

From a student's perspective, the essence of M-learning is the potential to learn from any location at any time using personal mobile devices [6],[8], including the support of all mobile learning methods by means of mobile computing devices or other mobile learning environments [9]-[11]. This can facilitate the educational process through mobile devices or in places where only mobile devices are available [12]. Furthermore, M-learning is a subset of e-learning, which means learning at the right time and in the right place that enables access to educational materials and communication with colleagues or with teachers at other educational institutions [13],[14]. In short, M-learning can be summed up as providing learning opportunities through mobile and handheld devices using learning applications that are compatible with smart device operating systems (OS). In addition, M-learning it can be considered as learning within one's own context in time and space [15],[16]. It is the central affordance of mobile technologies to facilitate learning, which is the key factor in any definition of M-learning.

II. LITERATURE REVIEW

With the wide spread of the coronavirus pandemic, digital transformation has become one of the basic aspects of many ministries that seek to benefit from providing an appropriate environment in which to activate communication channels and spread knowledge. Therefore, in the field of M-learning, we look at the importance of learning via mobile phones and the importance of learning by mobile phone in higher education in general and in academic institutions, particularly King Abdul Aziz University in Saudi Arabia.

One of the main reasons for using smart devices in the online learning field is the improvement of technologies that have appeared over the past decade [17]. This progress and achievement has contributed to reducing costs of learning compared to using desktop computers, which has led a wide range of societies to replace desktop computers with tablets or smart devices, which has further led to a steady increase in mobile device users [18],[19]. Additionally, smart devices provide many beneficial features such as cloud storage, instant access to the Internet, and continuous communication, which will help to increase their penetration and the confidence of users in their use [20].

The number of Internet users through 3G and 4G has reached more than 70% of all internet users in general, as indicated by the Communications and Information Technology Commission (CITC) in KSA [19]. This use has increased dramatically with the repercussions of the coronavirus pandemic over the past year. Therefore, there is great opportunity to benefit from the digital transformation trend by supporting mobile learning applications that are compatible with the 2030 vision of Saudi societies that serve the aspirations of the government and the people simultaneously [2]. With the limitations in the specifications

of mobile devices, many of the capabilities of smart devices remain untapped due to the relatively low level of technological awareness. Therefore, mobile devices can help easily target learners and spread the mobile learning approach more widely due to the limited options on the smart device screen, which helps to spread particular information smoothly and quickly [21],[22]. Furthermore, smart devices are widely used by residents of Saudi Arabia. Therefore, students can be involved in online learning activities, and female students can be included in learning activities without any societal restrictions.

A. M-learning's Importance for Higher Education

One of the significant advantages of e-learning is the availability of many useful functions and features related to online learning, such speed in interaction and sharing of information between learners. Smart devices do not require specialized skills to use and are lightweight, are easier to use than a keyboard and mouse, and take advantage of smart features such as Bluetooth and switching between the various levels of network coverage.

The study [23] indicated eight main activities that are beneficial in the M-learning 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 time and place restrictions [23]. These eight categories can be the main requirements for increasing the level of acceptance in M-learning applications. Moreover, the study [24] suggested that the widespread use of mobile devices on campus helps to provide multiple learning approaches and greater availability and flexibility for students [24]. 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 hold [25]; smart devices are becoming more acceptable compared with desktops [26]; smart devices help to increase the benefits of M-learning in the future through designed features and are built with the goal of future technological development [27]; and smart devices make a collaborative learning environment because they have social applications that can be integrated and used to share information, such as learning and teaching materials, including formative means for assessments and feedback between students and their teachers [26],[28].

III. THEORETICAL FRAMEWORK

Many studies in the field of electronic systems acceptance and adoption give priority to the requirements of the target audience and could be beneficial in increasing the level of acceptance in the M-learning fields. Therefore, many studies have provided an evaluation of the Technology Acceptance Model (TAM) focus, E-learning Acceptance Model (ELAM), and UTAUT model. The previous models presented are fundamental models in user attention and attention behavior requirements fields. These theoretical frameworks are related to the actual use and user acceptance in various field of M-learning.

A. Unified Theory of Acceptance and use of Technology

This study focuses on identifying the requirements of M-learning applications by studying the differences between the characteristic demographic groups. This could help to reach the target segment smoothly and easily. Additionally, this study searches for new development aspects in M-learning, particularly in an in-depth manner through theoretical frameworks that focus on consumer behavior.

UTAUT was developed by [29] by combining the characteristics of many previous theoretical frameworks, for example TAM, ELAM, & DOI, which focus on product characteristics and the characteristics of the target segment (see Fig. 1). Furthermore, UTAUT focuses on studying the differences between the poles of the target segment by applying moderators to understand the characteristics of the target segment. The moderators that were applied in this study were gender - experience - voluntary, which represents a direct impact on the acceptance and approval of electronic systems [29]. A number of studies have also indicated they eliminated some moderators who did not show the common differences between both sides, whereas the study [25] indicated that the age vector has been dispensed of, as students at the university have a similar age group between 22 to 30 years. Therefore, this age group has great common characteristics, which means that their interests are common and similar to some extent.

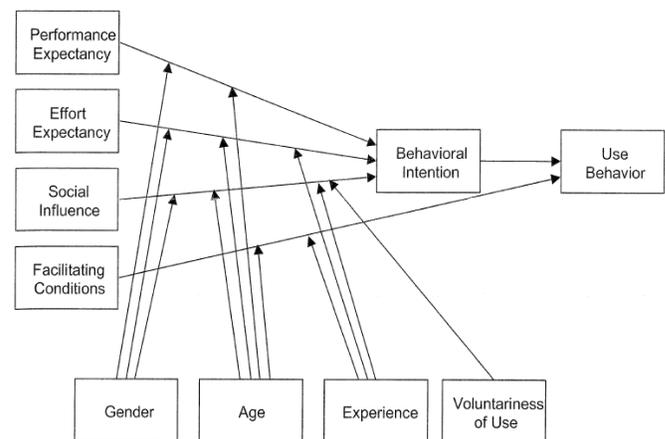


Fig. 1. The Unified Theory of Acceptance and use of Technology (UTAUT) Model.

As in study [20], it is important in bridging a gap in the analysis of gender and age as factors in M-learning technology acceptance. In particular, it was demonstrated that age differences moderate the impact of social influence and effort expectancy on M-learning using intention [20]. That is, for older mobile learners, a high effort expectancy and social influence may play a greater role in the acceptance of M-learning. Additionally, it was established that gender differences moderate the impact of self-management on learning and of social influence on M-learning acceptance. In particular, the study demonstrated that social influence is "...a stronger predictor of behavioural intention for men than for women" and "...self-management of learning influences

behavioural intention more strongly for women than for men” [20]. The authors hypothesized that the lesser impact of social influence on women may possibly be explained by “...women being more unfamiliar with relatively advanced and complex M-learning technology, making them less likely to be influenced by their close friends in the early stages of M-learning development” [20]. Although this hypothesis seems plausible, one must take the cultural and national context of M-learning acceptance into account, as that study was conducted among Taiwanese students (330 respondents), who may differ from their Western peers.

The study [30] investigated the factors that influence students’ intention to use M-learning. They tested and validated a model based on the UTAUT using a sample of students from the University of Technology Malaysia and analysed their quantitative data using the Statistical Package for the Social Sciences (SPSS). Briefly, [30] sought to derive a completely new model to explain or conceptualize M-learning. They began by arguing that M-learning has the potential to significantly enrich the education sector by putting educational content in the hands of all students without regard to their location. Their study concluded that M-learning is independent of the geographical location of both the learner and the instructor, and the former can learn continuously from any place. Thus, the authors set out to develop an integrated model that investigated the predictors of behavioral intention by university students to make use of M-learning. The main constructs used in this study were the self-management of learning and perceived usefulness. Both constructs have been deemed to be quite important determinants and predictors of behavior. Voluntariness of use has been added as a possible influencing factor on the behavioral intention to use M-learning [30].

The author in [25] also used UTAUT as a starting point from which to investigate the factors influencing M-learning acceptance among students. In particular, their study extended the UTAUT to include such variables as the quality of service, personal innovativeness, and the social influence of lecturers, which replaced the “facilitating conditions” factor of the initial UTAUT framework. To test the impact of these variables as well as the performance expectancy, effort expectancy, and lecturers’ influence, [25] conducted a survey of 174 participants from Brunei University. They excluded the age and gender moderators of the UTAUT framework, as the majority of the sample selected was made up of males of roughly the same age. Students’ prior experience with mobile technologies was selected as a key moderator in shaping their acceptance of M-learning. The study revealed that all factors and moderators had a significant impact on M-learning acceptance among Brunei University students. Effort expectancy was found to be the strongest predictor of students’ intention to use M-learning [25]. However, the authors acknowledged that the validity of these findings was limited in several respects. The limitations were the non-inclusion of actual M-learning usage in the research process and the potential bias of the sampling method (non-inclusion of female and elderly participants) [25].

B. Framework of M-learning Acceptance in Saudi Arabia

Following the examples provided by the reviewed studies, the current research uses the UTAUT framework as a starting point for the M-learning acceptance analysis. This framework was positively assessed by various researchers and was determined to provide an integrated vision of technology acceptance by exploiting the cumulative insights of other widely used frameworks [22],[25]. In addition, the UTAUT framework includes various moderating variables, such as age and gender that are central to understanding how the various technology acceptance factors may translate into the intention to use a given technology.

Notwithstanding its benefits, however, the UTAUT framework would also benefit from being adjusted to the specific context of M-learning technologies. Various studies discussed in the literature review have used adaptations of the UTAUT model, which include additional factors as perceived playfulness, personal innovativeness, attainment value, quality of service, and self-management of learning and self-efficacy, among others [20],[25],[30],[31]-[33]. Proceeding from the critical analysis of these contributions offered in previous parts, the present study next advances an extended UTAUT framework that includes the following parameters. Each parameter is defined according to the objectives of this study.

- Performance Expectancy: Personal belief in whether a type of information technology can contribute to educational and professional performance and/or success.
- Effort Expectancy: Attitude towards the effort (knowledge, information, and time) required to master a particular information technology.
- Lecturers' Influence: The extent to which a person believes in the importance of others' attitudes towards his/her usage of a given technology.
- Personal Innovativeness: A measure of a person's creativity and willingness to try out any new kind of information technology.
- Application Quality: The quality is defined as value that promotes satisfaction, appropriate use, and ultimately positive effects on the individual or organization, and thus affects the application’s capabilities and positive impact on user satisfaction. Fig. 2 outlines mobile application quality as a standalone factor in the model. It should be noted here that this term is made of three secondary factors that measure mobile application quality. As we wanted to measure individual responses to different aspects of quality, we chose the broad heading of mobile application quality and derived three measures from the systems quality literature discussed above.
- Behavioral Intention: One’s behavioral disposition towards the use of an information technology as affected by the above factors.

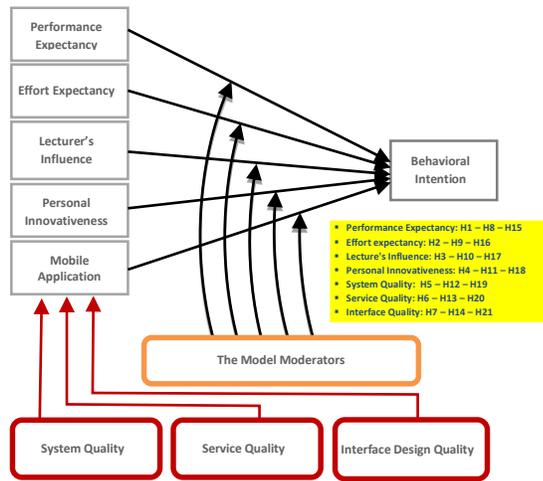


Fig. 2. The UTAUT (Modified) Model for Successful M-learning Application.

The proposed model utilizes three factors formulated in the initial UTAUT framework: effort expectancy, behavioral intention, and performance expectancy, as well as a modified “social influence” variable emphasizing the lecturers' influence in M-learning acceptance. Additionally, the framework extends the UTAUT to include personal innovativeness, which we consider to be important in understanding the M-learning context. In particular, personal innovativeness refers to an individual's willingness to acquire a creative experience with new information technology and also his or her ambition to develop personal creative capacities. The inclusion of personal innovativeness in the framework was motivated by the available evidence of its role in technology acceptance. In particular, the IDT framework suggests that innovative individuals are attracted to positive ideas and changes in technology and have higher levels of uncertainty tolerance [34]. Similarly, the [25] hypothesized that those students with high levels of personal innovativeness “would be more risk taking and have a more positive intention to use M-learning in their study” (p. 91). Also, mobile application quality concentrates on the quality assessment, which drives an increase in M-learning's acceptance level by students, as mentioned in detail in other previous parts of this research [7].

C. The Theoretical Framework for this Study

The proposed framework alters a set of UTAUT moderators by including gender, experience, and voluntary use. The age moderator was excluded because the proposed framework was tested on students from a similar age group from 19 and 25 years of age. The “voluntariness of use” moderator was divided into high and low levels of voluntariness, because the framework will be applied to regular M-learning courses at Saudi public universities but will be optional for online or on campus courses. The experience moderator was divided into two groups: a high level of experience (more than three years) and a low level of experience (three years or less). Similarly, the gender moderator was divided into two groups (female and male).

D. Summary of the Research Model Measurements

As presented in Section 2.7, the measurements used in this study are as follows:

Performance Expectancy (PE)

1. PE1: M-learning must be useful for the students' studies.
2. PE2: Using the M-learning applications should enable students to achieve learning tasks more quickly.
3. PE3: The use of M-learning in students' studies should increase their learning productivity.
4. PE4: M-learning applications should improve the users' collaboration with other classmates.
5. PE5: Using M-learning applications may gradually improve students' academic performance.
6. PE6: M-learning applications have clear educational goals.

Effort Expectancy (EE)

1. EE1: The M-learning application should be a flexible system that is easy to use.
2. EE2: Multimedia files should be provided to help users operate an M-learning system.
3. EE3: Clear and understandable instructions that let the user interact with M-learning application should be available.
4. EE4: The learning features of the M-learning applications should be easy to use.

Lecturer's Influence (LI)

1. LI1: I would use an M-learning application more if it were recommended by academic lecturers.
2. LI2: The M-learning application would be used if there were technical and academic support channels.

Personal Innovativeness (PInn)

1. PInn1: New M-learning applications and technology can be used without any reservations.
2. PInn2: It is important to provide the online educational resources for learning through smart devices.

Mobile Application Quality (MQ)

System Quality (MQSY)

1. MQSY1: Sufficient processing time is allowed to determine the actual courses or relevant material.
2. MQSY2: An advanced search mechanism in M-learning application is provided.
3. MQSY3: An adequate response time is allowed to download and launch the learning material on smartphone devices.
4. MQSY4: M-learning applications are able to support different languages.
5. MQSY5: Features that give M-learning applications the ability to support learners and tutors with different learning needs are offered.

6. MQSY6: The M-learning application has understandable language and is free from grammatical and syntactical errors.
7. MQSY7. The M-learning application is easy to find and install in any given device or system.

Service Quality (MQSE)

1. MQSE1: It is important that the content of the M-learning application systems is of high quality.
2. MQSE2: From a security perspective, the M-learning application systems are secure and keep confidential information in a safe place on the devices or in the application.
3. MQSE3: Providing a mechanism for updating information periodically is important.
4. MQSE4: Users can easily handle mobile devices and applications.

Interface Quality (MQIN)

1. MQIN1: The design of M-learning applications has to be in comfortable colors and fonts in the applications to be used.
2. MQIN2: A short menu and shortcut buttons should be included to allow users to easily access the application's main functions.
3. MQIN3: The functions required by individual users are provided.
4. MQIN4: M-learning applications should provide a drop-down menu for the most frequently used links.

Behavioral Intention (BI)

1. BI1: I use M-learning applications in my studies regularly.
2. BI2: I predict that I will use M-learning applications frequently.
3. BI3: I intend to increase my use of mobile services in the future.
4. BI4: I will enjoy using M-learning applications due to the appropriate features of this system.
5. BI5: I would recommend M-learning systems to others.

E. Moderator Hypotheses

The hypotheses related to the moderators measure the impact and the significant relationship of these moderators to the main constructs in the theoretical framework. A number of previous studies have indicated that individuals may have different characteristics because of their gender, experience, and level of voluntariness, which are the main moderators in UTAUT. The potential moderator of the age group was ignored because the sample is fairly homogenous in terms of age.

Some researchers have supported the concept that the expected effort will be a stronger determinant of women's individual intentions (e.g., [29], [35]). Also in study [20] and [36] noted the difference between women's behavioral intention in using M-learning and in using smart devices. Therefore, it is expected that students' acceptance of M-learning via smart devices depends on the ease of use as well

as societal characteristics based on the differences in moderator variables, which are divided into three sections: gender, experience, and level of voluntariness. Thus, the five hypotheses will be applied separately with each moderator, as presented in Appendix B.

IV. METHODOLOGY

This study sample was of students from the universities who have an existing infrastructure of distance learning in Saudi universities. Before the COVID-19 pandemic, the main three universities that had a distance learning sector and relevant magnificent structure were King Abdul Aziz University (KAU), Saudi Electronic University (SEU), and King Faisal University (KFU). The students at these universities were helpful to the research team because of their previous experience [37]-[39]. The availability of distance learning facilities at these universities was helpful in determining the main requirements for M-learning applications that might be beneficial to increasing these applications' level of acceptance.

The questionnaire was distributed to undergraduate students based on email lists supplied by the Office of the Deans of Information Technology at these universities. Other potential participants were selected from social networks such as Twitter, Facebook, and LinkedIn using the "snowballing" technique. This technique is useful in Saudi Arabia because willingness to participate is likely to be increased by receiving the invitation from a known person. The following conditional questions were used to filter participants who qualified as the main targets of this study:

- Have you ever used E-learning systems before?
- Do you use smartphone devices?
- Are you a resident of Saudi Arabia?
- Are you a higher education student? If yes, please enter your age (.....) and your degree program (Diploma/Bachelor/Master/PhD).

Positive answers to all of these questions qualified the participant for the survey and vice versa.

A. Data Analysis and Main Findings: Demographic Questions

The demographic questions are categorized into three main groups. The first group determines the participants' basic characteristics (Q1 to Q3) and focuses on participants' genders, ages, and educational levels. The second group concentrates on the characteristics of learning through M-learning applications (Q4 to Q6) and focuses on their previous experience with smart devices, level of knowledge regarding E-learning, and frequency of learning via electronic channels. The last group of questions focuses on the characteristics of working on smart M-learning devices (Q7 to Q11). This last group includes a focus on the type of internet service provided, the type of operating system used, the type of smartphone used in general, and the type of learning process adopted in particular. Appendix 1 summarizes the result of the demographic survey.

The results showed many principal points required focus. With respect to the first group of questions, both the male and female participants (46.2% and 53.62%, respectively) generally exhibited interest in online learning through smartphone applications. This finding is attributed to the spread of these devices in the Arabic region, particularly in Saudi Arabia. The responses to the second question indicated that, among the university students expressing considerable interest in online learning, 54% were studying for undergraduate degree programs and 45.09% were studying under master's or doctorate degree programs. This question was also intended to determine whether the bachelor's, master's, and doctorate students were aged between 18 and 30.

The second group of demographic questions highlighted three ideas of interest related in this study. First, measuring previous knowledge of dealing with smartphone applications was facilitated by experience with electronic applications in general and M-learning in particular. The findings showed that 36.18% of the students used M-learning applications for more than five years and that 58.45% had experience of between one and four years. Among the participants, 75.51% stated they had a good level of experience with applications and learning through mobile applications, which helped determine the main acceptance requirements of the target segment. The responses to Q4 and Q5 indicated that the experience and knowledge of the target segment were fairly high (42.49% and 36.18%, respectively). The responses to Q6, which focused on the participants' willingness to use M-learning applications through smart devices and their levels of preparation for such endeavor, reflected equality among the participants (High - Low) in terms of willingness.

In the third group of demographic questions, the responses to Q7 showed that 62.71% of the participants used the Internet daily. These results reflected the variety of options available for internet access and indicated that a larger segment of the sample preferred postpaid and DSL services, given the appeal of these offerings to the youth in Saudi Arabia. As shown in the responses to Q9, 3G users accounted for over 59.74% of the sample, whereas the 4G users did not exceed 25.23%, showing that fewer areas in Saudi cities and in the countryside are ready to provide 4G services by ISPs. Among the participants, 13.54% or less accessed Wi-Fi services. The responses to Q10 showed that 69.2% of the respondents used smartphones to connect to the Internet, supporting the importance of developing and implementing innovations that are compatible with M-learning smartphone applications. As shown in the responses to Q11, the participants regarded smartphones, iPads and tablets, ultra-laptops, and palmtop PCs as the most important devices used in online learning, with percentages being 92.95%, 67.72%, 79.41%, and 42.12%, respectively.

B. Testing the Moderator Hypotheses

A number of previous studies have delved into theoretical acceptance models, such as the UTAUT dealing with electronic system acceptance and consumer behavior, which is generally one of the fundamental aspects of increasing levels of technological acceptance [29]. One of the main reasons for establishing moderators in the UTAUT model is the need to

probe into the influence of moderators on the acceptance and use of electronic systems and the effects of traditional communities on such reception and adoption. According to study [25], different moderators influence the acceptance of technological systems. The use of moderators is an important approach to dealing with theoretical models that are grounded in the unique characteristics of specific communities.

In the relevant previous study, the basic analytical requirements, which centered on the reliability and stability of the theoretical framework were completed. The current study, the acceptance of M-learning through smartphones among Saudi higher education students, was illuminated on the basis of three moderators: gender, level of experience, and extent of willingness. The data was divided into two groups for each moderator. That is, gender was classified into male and female; level of experience was divided into high, which corresponds to more than three years, and low, which is equivalent to less than three years; and the extent of willingness was divided into high and low levels. The number of moderators by group is presented in Table I.

TABLE I. NUMBER OF RESEARCH MODERATORS BY GROUP

Moderator	Group Level	Sample Distribution by Moderator Group	
		N	P
Gender	Male	250	46.38%
	Female	289	53.62%
Experience	High	254	47.12%
	Low	285	52.88%
Voluntariness of Use	High	295	54.74%
	Low	244	45.27%

The purposes of these moderators were to identify the differences among the participants and determine the characteristics of acceptance of M-learning applications on the basis of the acceptance requirements identified in this study. Correlation coefficients, critical ratios, and p-values were used for each construct to pinpoint the differences in relationships between the constructs. The chi square (χ^2) and degree of freedom (df) were likewise necessary in calculating the differences among the groups of moderators. Computing the path of differences among the moderator groups necessitated calculating all the 21 hypothesized paths (gender - experience - willingness) to determine any significant path in the model. Then, insignificant paths were removed, and effective paths were retained in the moderator groups. Subsequently, the χ^2 and df of the constrained and unconstrained models were calculated to determine the level of change in the groups' model ($df = 1$) and to identify significant paths [40].

The grouping of the participants was determined according to the division of the theoretical model's moderators. The males accounted for 46.38% of the sample, and the females accounted for 53.62% (see Table II). The relationships between the constructs on the basis of gender were PE → BI - EE → BI - LI → BI - PInn → BI - MQSY → BI - MQSE → BI - MQIN → BI, all of which were significant, except for LI → BI - PInn → BI. This means that the gender moderator

reflected high interest among Saudi university students in learning through M-learning applications. The constrained and unconstrained tests indicated a significant difference between the males and females and significant relationships between BI and PE, EE, MQSY, MQSE, and MQIN in both the male and female groups.

Experience was treated as a principal moderator because it is a key driver of the acceptance and use of M-learning

applications. Among the participants, 47.12% and 52.88% had high and low experience with M-learning applications, respectively. The relationships reflected based on the experience moderator were similar to those demonstrated based on the gender moderator. LI → BI and Plnn → BI had no significant relationship with respect to experience, but the other hypothesized relationships were significant among the respondents with high and low experience.

TABLE II. SUMMARY OF PATH COEFFICIENTS, T-VALUES AND P-VALUES FOR GENDER AND EXPERIENCE MODERATORS

Gender		Male, N= 250, 46.38%			Female, N= 289, 53.62%			Constrained model		Unconstrained model		Δ (df =1)	Testing result
		Estimate	t-value	P	Estimate	t-value	P	χ ²	df	χ ²	df		
H1	PE → BI	0.573	5.829	***	0.629	6.498	***	3455.3	57	3450.9	51	4.4	Supported
H2	EE → BI	0.626	4.998	***	0.701	6.209	***	3227.8	55	3221.2	50	6.6	Supported
H3	LI → BI	0.637	6.422	.123	0.503	7.193	***						N.S
H4	Plnn → BI	0.765	5.760	***	0.601	5.238	.142						N.S
H5	MQSY → BI	0.684	6.343	***	0.660	7.326	***	3460.8	59	3449.9	53	10.9	Supported
H6	MQSE → BI	0.505	6.116	***	0.561	7.002	***	3170.8	58	3159.9	54	10.9	Supported
H7	MQIN → BI	0.655	5.571	***	0.741	6.935	***	3256.8	60	3243.9	55	12.9	Supported
Experience		High – more than four years, N= 254, 47.12%			Low – Less than four years, N= 285, 52.88%			Constrained model		Unconstrained model		Δ (df =1)	Testing Result
		Estimate	t-value	P	Estimate	t-value	P	χ ²	df	χ ²	df		
H8	PE → BI	0.611	6.133	***	0.589	6.294	***	3479.7	51	3473.3	49	6.4	Supported
H9	EE → BI	0.513	4.655	***	0.600	6.421	***	3339.7	52	3323.3	48	16.4	Supported
H10	LI → BI	0.661	7.297	.234	0.607	6.697	***						N.S
H11	Plnn → BI	0.694	7.237	***	0.622	4.687	.412						N.S
H12	MQSY → BI	0.551	6.924	***	0.606	7.180	***	3361.5	50	3353.3	49	8.2	Supported
H13	MQSE → BI	0.622	7.051	***	0.697	6.798	***	3430.3	49	3422.3	50	8	Supported
H14	MQIN → BI	0.531	6.332	***	0.587	6.751	***	3485.12	51	3475.1	51	10.02	Supported
Willingness to Use		High – more than four years, N= 295, 54.74%			Low – Less than four years, N= 244, 45.27%			Constrained model		Unconstrained model		Δ (df =1)	Testing Result
		Estimate	t-value	P	Estimate	t-value	P	χ ²	df	χ ²	df		
H15	PE → BI	0.689	6.414	.163	0.525	5.988	.127						N.S
H16	EE → BI	0.543	5.559	***	0.691	5.693	.151						N.S
H17	LI → BI	0.660	7.059	.265	0.587	6.583	***						N.S
H18	Plnn → BI	0.590	5.218	***	0.668	5.646	***	3089.822	52	3089.492	51	0.33	N.S
H19	MQSY → BI	0.596	6.951	***	0.553	6.687	***	3090.822	54	3082.492	50	8.33	Supported
H20	MQSE → BI	0.615	6.881	***	0.558	6.279	***	3060.822	52	3055.492	53	5.33	Supported
H21	MQIN → BI	0.582	6.414	***	0.628	6.231	***	3087.822	49	3084.492	57	3.33	Supported
Notes: PE = Performance Expectancy, EE = Effort Expectancy, LI = Lecturers' Influence, Plnn = Personal Innovativeness, MQSY = System Quality, MQSE = Service Quality, MQIN = Interface Quality, BI = Behavioural Intention; - *p < 0.1, **p < 0.05, ***p < 0.001													

Willingness to learn through M-learning applications is an equally important aspect of technological acceptance. The use of learning techniques to enrich and spread education is paramount, because the users have all the fundamental requirements that they need to learn through M-learning applications. This is expected to increase willingness and interesting opportunities to learn through educational applications. Out of the participants, 54.74% and 45.27% exhibited high and low willingness, respectively. The relationships PE → BI, EE → BI and LI → BI were nonsignificant with respect to both high and low willingness, but the other hypothesized relationships were significant (see Table II). The relationship Plnn → BI was insignificant under the Δdf computation; thus, this relationship was eliminated because of its insignificance. The relationship MQSY → BI - MQSE → BI - MQIN → BI was significant for those with both high and low willingness. As shown in Table II, most of the hypothesized paths for the gender, experience, and willingness moderators were important and significant with respect to the sample. MQSY, MQSE, and MQIN were also significant under both divisions of each of the three moderators.

V. DISCUSSION

There are two main questions associated with the current research. Therefore, M-learning applications can be implemented in accordance with various supportive functions and user features in KSA society, and the main difference between the two sides of the target audience moderators can be determined.

How can M-learning applications be appropriately implemented in accordance with the technical support, awareness and knowledge, and tools and features connection functions in KSA?

This section clarifies and combines the main M-learning requirements that are important for the target audience of this study. The questions presented for some these requirements were mentioned in the open-ended questions in the survey. These requirements are presented in detail in Fig. 3, which focuses on the various difficulties encountered by users.

The requirements were categorized into three groups. The first is technical support, which pertains to the development of tools that support users and the manner in which appropriate solutions to problems are formulated. The second is awareness and knowledge, which centers on the presentation of information and features that users need to motivate their engagement with M-learning applications. The third concerns the tools and features connection, which revolves around the tools, capabilities, and features that hasten the evolution of the M-learning process and the full connection of applications with users. The first and second groups are critical in increasing M-learning acceptance and use, and the third attaches credibility to such applications and ensures their availability for use by the target segments. Although the third group is regarded only as moderately valuable, it is still important to provide a way to link consumers and M-learning applications. The viewpoints shared by the participants were consolidated to enable the management of the requirements

related to each group. The consolidation resulted in eight elements, as listed in Table III.

As previously stated, the open-ended questions were intended to gain a broad picture of the developmental requirements for M-learning applications from the target audience. Identifying issues and proposing appropriate solutions based on students' perspectives may determine what application features are suitable for this population. The participants proposed several services for supporting and connecting content in M-learning applications for instructors, developers, and students (as presented in Fig. 3).

TABLE III. M-LEARNING APPLICATION REQUIREMENTS FROM BOTH THE STUDENTS' AND DEVELOPERS' PERSPECTIVES

No.	Requirements	Related Group
1.	Provide online support services for operating and activating M-learning applications through discussions with an experienced team.	Technical Support
2.	Provide basic information that a user needs to run an application (instructions).	Awareness & Knowledge
3.	Provide basic information that explains the advantages and features of M-learning applications.	
4.	Implement regulations and policies for education in general and M-learning in particular.	
5.	Clarify rights and responsibilities, including those related to safety and privacy, in dealing with M-learning applications.	
6.	Provide information and explanations that increase the acceptance of M-learning applications and the confidence in using them.	Tools & Features Connection
7.	Provide data storage methods, whether these are in-device features or external repositories, such as servers or cloud platforms.	
8.	Ensure the availability and reliability of an electronic presence across different channels of communication for the servicing of E-learning and M-learning needs.	

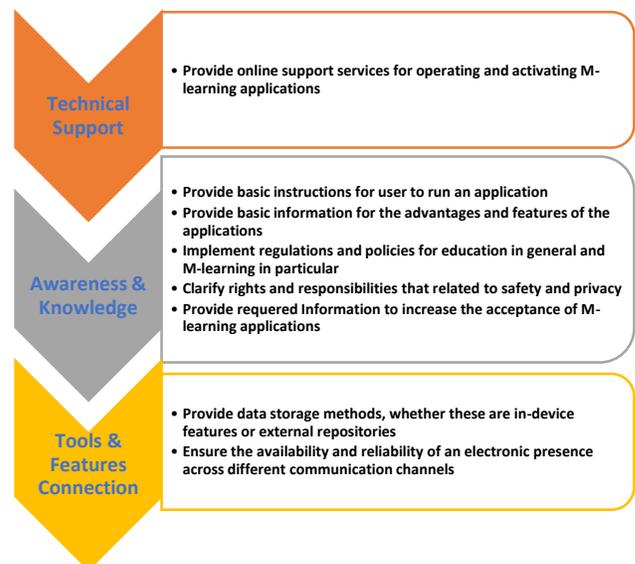


Fig. 3. M-Learning Application Requirements from both the Students' and Developers' Perspectives.

How do gender, experience, and willingness influence the acceptance and use of M-learning applications in KSA?

A. Effects of Gender

The gender moderator significantly affects the relationship between BI and the other constructs (PE, EE, MQSY, MQSE, MQIN) and plays a key role in moderating M-learning acceptance in relation to the aforementioned constructs. The results on the hypotheses related to gender are positive, confirming that females are more strongly affected by M-learning applications than are males, but the first test on the hypotheses generated empirical evidence that both genders have a strong relationship with the use of M-learning applications (see Table II). The respondents specified the effort that they expect to exert in dealing with various learning stages and expressed the belief that they can accomplish their online learning missions through M-learning applications.

This accomplishment can be included as a core expectation from users given that online learning through smart devices reduces the effort and time required to complete learning tasks and reflects academic performance as accurately as possible [36],[41]. Effort is a concern of the target users, and the statistical results indicated that expected effort is significantly associated with both genders. Both the male and female participants recognized the importance of expected effort in relation to many different aspects of online learning. Examples of these aspects are high flexibility in learning through M-learning applications, the availability of multimedia and assistive instructions, and the highlighting of features that help elevate learning on these applications [42]. As expected effort facilitates a thorough engagement with applications, providing online learning resources and other features and tools may increase such engagement, acceptance, and reuse in various disciplines and for various purposes [42],[43].

Generally, both genders moderated the relationship between LI and PInn and the relationship between LI and BI, and no difference existed between males and females as to this moderation [44]. The aforementioned relationships are therefore of a normal nature.

Quality requirements are viewed as an important component because MQ is significantly related to both genders in terms of the public relations ideas expressed in H5, H6, and H7. However, this level of importance is greater among women than men in the gender moderator tests, supporting the earlier consideration of providing equal educational opportunities for women in Saudi Arabia [36],[45]. Saudi family orientations and community traditions dictate that women stay at home rather than venture outside, unlike Western women, and Saudi females serve inside the houses more often than do Saudi males. Gender segregation in formal education also denies women many educational opportunities [3]. The results on gender pointed to the need for fairness in education for Saudi women—a goal that can be achieved through the provision of education via various electronic services, including M-learning [badwelan].

Females ascribed significant importance to using the M-learning applications compared with males, as evidenced by

the difference between the constrained and unconstrained model tests (see Table II). That is, it is more important to determine women's requirements than those of men because, despite the value of establishing a framework commensurate with the desires of both genders, females are the main target group for the acceptance and use of M-learning applications [36],[45]. Nevertheless, these results should encourage interested private sector companies in Saudi Arabia to continue developing and designing features that fit the requirements of both men and women as the findings on gender as a moderator confirmed that both groups strongly wish to accept and use M-learning applications.

B. Effects of Experience

As stated in [29], the experiential impact of electronic applications is one of the most important moderators of BI. In the current research, the experience of dealing with smart device applications is an equally vital mediator of the relationships between PE, EE, LI, PInn, MQSY, MQSE, and MQIN as the core constructs and BI as the target construct (see Table II). The experience moderator measures the experience that builds upon high and frequent demand for the use of an information space through smart devices and internet connectivity [46]. The results indicated that actual and high access to the Internet through smart devices, laptops, or desktops markedly increases the usage of smart device applications [19]. High engagement with the Internet means users would be considerably proficient in identifying the features that would elevate their acceptance of M-learning applications [29],[47]. The findings also demonstrated that previous experience helps attract highly proficient internet users. PE, EE, MQSY, MQSE, and MQIN thus have a significant relationship with the behavioral intention to use easy and/or complex M-learning applications, which explains why more comprehensive encounters with such innovations increases their acceptance.

The results regarding H8, H9, H12, H13, and H14 support the principal function of internet usage in increased acceptance. Many examples in the literature on the smartphone context corroborated the proposition that dealing with smart device applications helps augment the chances that they will be adopted by university students. The results of the present research are therefore consistent with those of a number of previous studies, including [29],[34],[35].

C. Effects of Willingness

Willingness was another key moderator used to measure the acceptance and use of smart device applications. Voluntary usage, instead of compulsory adoption, facilitates the patronage of technology and many different electronic systems [28]. Willingness can be employed to measure user awareness of how to deal with M-learning applications, what their advantages are and how to obtain information that can persuade users of the benefits of their use [2]. The results on willingness showed that this moderator is significantly related to system, service, and interface quality, as proposed in H19, H20, and H21. Quality exerts a positive impact on increasing willingness and, hence, the BI and actual use by target users in the future [26],[48]. The availability of various quality features elevates willingness, as suggested in the positive

results for the aforementioned hypotheses [49]. The difference between increases in users' engagement with educational applications may be attributed to the availability of these quality features. The statistical findings are consistent with those of previous studies (e.g., [2],[25],[28],[50]).

VI. IMPLICATIONS

Apart from the UTAUT framework-based identification of requirements, other research questions contributed to pinpointing many other needs related to increasing awareness and knowledge of the use of M-learning applications. There are some implications related to this study that are summarized in the following parts.

1) *Technical support for learning applications:* The study discovered a weakness in the technical support for M-learning applications, making this one of the main obstacles to their acceptance and adoption [36],[45],[51]. The most reliable way to deal with technical service problems is to effectively provide technical support. Even though technical support failures may be minor, these may rapidly reduce the appeal of electronic systems to target users [56]. Therefore, a highly qualified technical support team should be tasked with quickly detecting and responding to technical problems or user requests. Responses to target users' queries should be highly efficient, and support teams should be able to demonstrate how online learning tools are used.

"Technical support" should also be defined to determine what functions can be covered under this term [36], [51]. The author in [52] described technical support as the "information that helps users of computer solutions to be outstanding, whether in hardware or software." Technical support can thus mean a help desk, an information center, an online communication channel, a telephone call system, an email response system, and other similar facilities. The study [36] emphasized that technical support requirements are key points that may increase the acceptance of M-learning applications in smartphones.

2) *Lack of awareness of e-government services:* The study also identified a lack of awareness and information about online learning services, and this requirement ranks second to technical support as a fundamental and important component [53]. The availability of comprehensive information may increase awareness of M-learning applications and their usage [36]. The information needed by target users differs depending on the traditions and abilities of communities. The information required by Saudi university students to raise their awareness and knowledge of M-learning centers on five key aspects.

Firstly, this population requires basic information on operating online learning applications. Secondly, they need information that improves their understanding of the features and services available in M-learning applications. Thirdly, they require accurate policies and regulations for learning and E-learning. Fourthly, the rights and responsibilities of users and developers of M-learning applications should be clarified and concentrate on safety and privacy. Finally, they need clarifications that help them run M-learning applications more

professionally and thereby increase their acceptance and confidence in dealing with these technologies [45],[51].

Providing the many types of information users need for understandability increases the possibility of use and the BI to engage with these online learning applications in the student communities of Saudi universities [53]. In addition, students can be persuaded to use M-learning applications through promotions and advertisements in social networking sites, which are frequently visited by university students, or through discount cards for subscriptions to the educational materials available on smartphone applications [2]. Previous studies have demonstrated that there are generally many ways to raise awareness of any new technology or service and support its use [2],[43],[54].

3) *Availability and reliability of internet connection:* The availability of high-speed internet services may inspire community acceptance and usage of M-learning. High-speed internet enables users to download basic information and resources via applications, making such connectivity a feature that most reliably motivates engagement with M-learning applications [55]. Naturally, slow internet speeds negatively affect the operation of electronic applications and reduce users' motivation to use M-learning technologies [47].

One of the key reasons for poor connectivity in Saudi Arabia is the implementation of filters and firewalls for secure internet access; this regulation is overseen by the Communications and Information Technology Commission, and it means that access to information resources is slower in Saudi Arabia than in countries that do not have such a filter system for internet resources [56].

High-speed connectivity increases the motivation of target users to try out the various features of M-learning applications and reduces the effort needed to engage with electronic systems or the time spent accessing informational resources [47]. Connecting to the Internet can also shorten certain tasks that usually take considerable effort and time through traditional learning methods (e.g., visiting universities or academic centers in person to obtain information versus acquiring the same information by navigating the resources included in online learning applications).

VII. CONCLUSION

This study focused on determining the target audience's main characteristics that could be helpful in activating a digital transformation through M-learning methods in smart phones. This approach defined the target segment in Saudi universities, a large segment, for using smart phones in Saudi Arabia, along with most internet users through smart phones. Therefore, automation services in M-learning represent one of the most important means supporting the transfer and dissemination of knowledge. This study focused on identifying the number of basic requirements related to different groups of moderators (Technical Support - Awareness & Knowledge - Tools & Features of Connection). One of the main benefits for studying the target audience characteristics is spreading the M-learning approach through smart devices in higher education institutions and universities

in Saudi Arabia to support the Saudi 2030 vision through applying the digital transformation solution in various aspects of life. The quantitative method was used to determine these characteristics, which are expected to have the greatest effort throughout the coronavirus pandemic, as this approach is expected to help to with adoption of M-learning applications by the target audience according to the number of technical and design requirements contained in this study.

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APPENDIX A: (DESCRIPTIVE RESULT OF DEMOGRAPHIC QUESTIONS)

Results of Demographic Questions (N = 539)		
Category of Participants	No.	%
Q1. Gender		
Male	289	53.62
Female	249	46.2
Missing	1	0.19
Q2. Age Group		
18 Years or Less	12	2.23
19 – 20	38	7.05
21 – 22	92	17.07
23 – 24	105	19.48
25 – 26	93	17.25
27 – 28	67	12.43
29 – 30	61	11.32
31 Years or More	66	12.24
Missing	5	0.93
Q3. Level of Education		
Undergraduate	70	12.99
Graduate	221	41
Master	202	37.48
PhD	41	7.61
Missing	5	0.93
Q4. Experience with Smartphones		

Less than 1 year	22	4.08
1-2 Years	86	15.96
3-4 Years	229	42.49
5 years or more	195	36.18
Missing	7	1.3
Q5. Level of E-learning Knowledge		
Moderate	57	10.58
Good	183	33.95
Very good	224	41.56
Nothing	74	13.73
Missing	1	0.19
Q6. Extent of Willingness to Use M-learning Applications		
High	252	46.75
Medium	53	9.8
Low	233	43.22
Missing	1	0.19
Q7. Frequency of Online Service Usage for Learning		
1 time per week	42	7.79
1-5 times per day	199	36.92
5-10 times per day	139	25.79
More than 10	40	7.42
1 time per week	117	21.71
Missing	2	0.37
Q8. Internet Plan		
Mobile postpaid SIM with Internet service	279	51.76
Prepaid SIM card with Internet service	12	2.23
Data SIM card	83	15.4
DSL	165	30.61
Missing	0	0
Q9. Type of Internet Service Providers (ISPs)		
Wi-Fi	73	13.54
3G	322	59.74
4G	136	25.23
Missing	8	1.48
Q10. Kind of Smartphone Used (Multiple Answers Possible)		
Smartphone	373	69.2
Tablet/ iPad	73	13.54
Ultra laptop	84	15.58
PDA/palmtop	9	1.67
Missing	0	0
Q11. Preferred Device for Use in M-Learning (Multiple Answers Possible)		
Smartphone	501	92.95
Tablet/ iPad	365	67.72
Ultra laptop	428	79.41
PDA/palmtop	227	42.12
Missing	3	0.56

APPENDIX B: THE HYPOTHESES OF MODERATORS

A. *The Hypotheses of Gender Moderator*

- H1. Increased performance expectancy will have a positive effect on the behavioural intention to use M-learning for female more than for male users of mobile devices.
- H2. Reduced effort expectancy will have a positive effect on the behavioural intention to use M-learning for female more than for male mobile device users.
- H3. The lecturer's influence has a positive or negative influence depending on whether they support and understand M-learning for female more than for male users of mobile devices.
- H4. Increased personal innovativeness has a positive effect on the behavioural intention to use M-learning for female more than for male users of mobile devices.
- H5. Increased 'mobile application system quality' has a positive influence on behavioural intention to use M-learning more positively for female than for male users of mobile devices.
- H6. Increased 'mobile application service quality' has a positive influence on behavioural intention to use M-learning more positively for female than for male users of mobile devices.
- H7. Increased 'mobile application interface quality' has a positive influence on behavioural intention to use M-learning more positively for female than for male users of mobile devices.

B. *The Hypotheses of Experience Moderator*

- H8. Increased performance expectancy will have a positive effect on the behavioural intention to use M-learning for more experienced users of mobile devices than for less experienced users.
- H9. Reduced effort expectancy will have a positive effect on the behavioural intention to use M-learning for more experienced users of mobile devices than for less experienced users.
- H10. The lecturer's influence has a positive or negative influence depending on whether they support and understand M-learning for more experienced users of mobile devices than for less experienced users.
- H11. Increased personal innovativeness has a positive effect on the behavioural intention to use M-learning more positively for more experienced users of mobile devices than for less experienced users.
- H12. Increased 'mobile application system quality' has a positive influence on behavioural intention to use M-learning for more experienced users of mobile devices than for less experienced users.
- H13. Increased 'mobile application service quality' has a positive influence on behavioural intention to use M-learning for more experienced users of mobile devices than for less experienced users.
- H14. Increased 'mobile application interface quality' has a positive influence on behavioural intention to use M-learning for more experienced users of mobile devices than for less experienced users.

C. *The Hypotheses of Voluntariness of Use Moderator*

- H15. Increased performance expectancy will have a positive effect on the behavioural intention to use M-learning more positively in voluntary users of mobile devices than it does in less voluntary users.
- H16. Reduced effort expectancy will have a positive effect on the behavioural intention to use M-learning more positively in voluntary users of mobile devices than in less voluntary users.
- H17. The lecturer's influence has a positive or negative influence depending on whether they support and understand M-learning more positively in voluntary users of mobile devices than in less voluntary users.
- H18. Increased personal innovativeness has a positive effect on the behavioural intention to use M-learning more positively in voluntary users of mobile devices than in less voluntary users.
- H19. Increased 'mobile application system quality' has a positive influence on behavioural intention to use M-learning more positively in voluntary users of mobile devices than in less voluntary users.
- H20. Increased 'mobile application service quality' has a positive influence on behavioural intention to use M-learning more positively in voluntary users of mobile devices than in less voluntary users.
- H21. Increased 'mobile application interface quality' has a positive influence on behavioural intention to use M-learning more positively in voluntary users of mobile devices than in less voluntary users.