THE EFFECT OF TECHNICAL FACTORS ON ACCEPTANCE OF USING MOBILE LEARNING: AN EXTENDED MODEL

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THE EFFECT OF TECHNICAL FACTORS ON ACCEPTANCE OF USING MOBILE LEARNING: AN EXTENDED MODEL

ABSTRACT

There is no doubt that mobile devices such as smartphones have become an important tool in the higher education domain. Even though the features and functions of these devices help learners in performing their learning activities, the usage of these devices for learning remains relatively limited amongst students. The low usage of these devices in learning field could be attributed to several reasons relating to technical or non-technical issues. Many acceptance models were developed to measure factors affecting usage of technology, as well as mobile learning. However, limited studies discussed the advantages of the technical aspects, such as device performance, connectivity, processing power, and memory of imparting knowledge through mobile learning. Therefore, there is a need to investigate these limitations of using mobile devices in education to understand the factors that could improve students' usage of these devices for mobile learning in higher education. In order to achieve this outcome, this study aimed to propose a model for measuring the acceptance of mobile learning that emphasises on technical factors to determine the main factors that influence the use of mobile learning by students. New technical factors were proposed, such as Device Compatibility, Device Connectivity, Device Memory Capacities, Device Performance, Device Processing Power, Security and Reliability of Mobile Learning on Device, Network Coverage, and Network Speed. These factors were used to extend The Unified Theory of Acceptance and Use of Technology model for a better understanding of students' acceptance of mobile learning. Structural equation modelling was employed to analyse data collected from 612 students to verify the validity of the proposed model. The results indicated that factors such as

Device Compatibility, Device Connectivity, Device Memory Capacities, Device Performance, Network Coverage and Network Speed have a significant and positive influence on the intention of students to use mobile learning. A guideline is proposed based on the proposed model. This research presents important recommendations for decision-makers and developers on understanding the needs of students in adopting M-learning effectively as a useful learning tool.

Keywords: mobile learning; technical factors; mobile learning acceptance model; TAM; UTAUT

PENGARUH FAKTOR TEKNIKAL KE ATAS PENERIMAAN DALAM PENGGUNAAN M-PEMBELAJARAN DI UNIVERSITI HAIL: MODEL LANJUTAN

ABSTRAK

Tidak dapat dinafikan bahawa peranti mudah alih, seperti telefon pintar telah menjadi alat penting dalam domain pendidikan tinggi. Walau pun ciri-ciri dan fungsi peranti ini membantu pelajar dalam melaksanakan aktiviti pembelajaran mereka, penggunaan peranti ini untuk pembelajaran tetap agak terhad di kalangan pelajar. Penggunaan yang rendah oleh peranti ini mungkin boleh dikaitkan dengan beberapa faktor yang berkaitan dengan isu-isu teknikal atau bukan teknikal. Banyak model penerimaan telah dibangunkan untuk mengukur faktor-faktor yang mempengaruhi penggunaan teknologi serta pembelajaran mudah alih. Walau bagaimanapun, kajian yangmembincangkan kelebihan aspek teknikal seperti prestasi peranti, penyambungan, kuasa pemprosesan dan memori menyampaikan ilmu melalui pembelajaran mudah alih masih terhad. Oleh itu, terdapat keperluan untuk menyiasat batasan penggunaan peranti mudah alih dalam pendidikan untuk memahami faktor-faktor yang dapat meningkatkan penggunaan peranti ini untuk pembelajaran mudah alih dalam pendidikan tinggi. Untuk mencapai hasil ini, kajian ini bertujuan untuk mencadangkan model untuk mengukur penerimaan pembelajaran mudah alih yang menekankan faktor teknikal untuk menentukan faktor utama yang mempengaruhi penggunaan pembelajaran mudah alih oleh pelajar. Faktor teknikal baru dicadangkan, seperti Keserasian Peranti, Sambungan Peranti, Kapasiti Memori Peranti, Prestasi Peranti, Kuasa Pemprosesan Peranti, Keselamatan dan Kebolehpercayaan Pembelajaran Mudah Alih pada Peranti, Liputan Rangkaian dan Kelajuan Rangkaian. Faktor-faktor ini digunakan untuk memperluaskan model Teori Penerimaan dan Penggunaan Teknologi Bersatu untuk pemahaman yang lebih baik mengenai penerimaan pelajar terhadap pembelajaran mudah alih. Pemodelan persamaan struktur telah digunakan untuk menganalisis data yang dikumpulkan daripada 612 pelajar untuk mengesahkan kesahihan model yang dicadangkan. Keputusan menunjukkan faktor seperti Keserasian Peranti, Sambungan Peranti, Kapasiti Memori Peranti, Prestasi Peranti, Liputan Rangkaian dan Kelajuan Rangkaian mempunyai pengaruh penting dan positif terhadap minat pelajar untuk menggunakan pembelajaran mudah alih. Penyelidikan ini membentangkan cadangan penting untuk pembuat keputusan dan pemaju mengenai memahami keperluan pelajar dalam menerima pakai M-pembelajaran dengan berkesan sebagai alat pembelajaran yang berguna.

Kata kunci: pembelajaran mudah alih; faktor teknikal; model penerimaan pembelajaran mudah alih; TAM; UTAUT

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LIST OF ABBREVIATIONS

Abbreviations	Description
DC	Device Compatibility
DCO	Device Connectivity
DM	Device Memory
DP	Device Performance
DPP	Device Processing Power
EE	Effort Expectancy
E-Learning	Electronic Learning
IU	Intention to Use
M-learning	Mobile Learning
NC	Network Coverage
NS	Network Speed
PE	Performance Expectancy
PV	Price Value
SI	Social Influence
SRML	Security and Reliability of Mobile Learning on Devices
TAM	The Technology Acceptance Model
UTAUT	The Unified Theory of Acceptance and Use of Technology

CHAPTER 1

INTRODUCTION

1.1 Introduction

With the earth's population reaching more than six billion people, there are about two billion mobile phones being used around the world. This comes with a great development in the telephones that enables them to deal with many files of various kinds (Tamilarasan et al., 2019). The use of mobile devices such as smartphones, for example, has become an essential, if not a luxury item and accessory for many users in performing a vast array of tasks and functions. Historically, mobile devices and associated technology continue to develop exponentially, helping users to complete tasks quickly, perform transactions, as well as access the internet to find information and for entertainment (Almaiah et al., 2016).

Current developments in the telecommunications sector are emerging to help in serving the community in several ways. This is evident by the number of subscribers to telecommunication services over the past few years (ITU, 2014). Given the growth of this technology, the use of the internet has become a common place in peoples' lives worldwide not just to communicate, but also to watch video broadcasts and make video calls. Nowadays, the Internet nowadays enables users all over the world to connect to each other at any time no matter their locations (AlHunaiyyan et al., 2017). Indeed, at present, the use of fifth-generation networks such as 5G is emerging and driven by previous generations of networks that have enhanced the adoption and growth in the use of mobile devices, such as smartphones. For instance, in fourth-generation networks such as 4G, notable developments and advancements were made in numerous domains, including multimedia, video broadcasting, data transmission, and security at reaching users in many parts of the globe through different types of devices (Arshad et al., 2010). Some educational authorities accept the use of mobile learning (M-learning) in universities; however, the application and use remain a challenge for students (Kayode et al., 2019). These obstacles may be related to technical and non-technical aspects, such as device capabilities, network coverage, facilitating conditions, and social influences (Almaiah et al., 2016).

4G is the fourth generation of communication technology (Arshad et al., 2010), which increases the effectiveness of the special services and multiple videos through wireless networks and media. With 4G already existing and 5G implementation has begun in some countries, using smart phones in education might be a reasonable choice. Joint actions across the world to 4G technology has resulted in several developments in terms of speed, performance, reliability, fault tolerance, portability, interoperability, and latency in real-time applications. Services contributed by the fourth-generation multi-technology includes a higher connection speed, wider network spectrum, better visual channels, and more flexibility in communications among others (Bai et al., 2012). These improvements in the services certainly lead to better applications for M-learning. M-learning offers many benefits to learners, including:

1. Speed in accessing knowledge and reaching information in a relatively short time,

2- The ability to communicate with others in order to learn and share educational content,

3- Providing many ways of learning and not necessarily being in a specific place or time,

4-Continuity of education without the need for formal procedures, such as enrolment in schools and others (Campbell, 2018).

Various studies have demonstrated the wide acceptance of the application of mobile phones as a medium of learning. For instance, a study reported that about 95% of students supported the use of mobile phones to communicate with classmates and teachers as it is faster than the classic methods (Daniel, 2016). In addition, several scientific voices call for studies on students' attitude toward learning using phones (Ibrahim et al., 2017). Involving mobile technology in the learning process may face difficulties, especially in developing countries. These obstacles may be related to technical and non-technical aspects, such as device capabilities, network coverage, facilitating conditions, and social influences (Almaiah et al., 2016). These challenges have been suggested as the underlying reasons for the poor implementation and low acceptance rates of mobile technology in learning processes in developing countries. According to Oyelere et al. (2016), one of the most important issue is technical constraints (Oyelere et al., 2016) as such will prevent students from optimising the application of the related technologies (Jinot, 2019). Due to the weakness of technology substructure in Africa, incorporating M-learning among its postgraduates may be challenging (Kaliisa & Picard, 2017). Despite the extensive studies on M-learning and non-technical factors, there is still data paucity regarding students' attitude towards M-learning (Ibrahim et al., 2017; Masrom & Hakemi, 2019; Almaiah & Al Mulhem, 2019). It is important to note that only a few studies considered technical factors and it has not been investigated as the main objective in any research.

With the massive development in the use of mobile phones and their applications in the field of educational process, many studies have measured the students' acceptance of M-learning and the influencing factors. Most of the studies were based on models designed in the past to measure the acceptance of students. In addition, technology acceptance model (TAM) and the unified theory of acceptance and use of technology (UTAUT) were the most cited models (El-Masri & Tarhini, 2017). These studies generally added or modified some factors in the studied models. The widespread use of mobile phone devices has led to the need for a particular model that measures to what extent students or learners accept this technology in the learning process. Based on the review of previous research, it was concluded that no study has focused on technical factors (i.e., hardware performance, memory capacity and others) and their impact on learners' intention to use M-learning (Bidin & Ziden, 2013).

In another systematic review conducted by Alghazi et al. (2020), the authors analysed about 127 studies published in the last 10 years. It was found that most of the constructs in the studies involved general models, rather than pure technical factors or technically related to devices or systems such as memory capacity and processing power. Despite the increasing interest in M-learning context field in recent years, studies focusing on this are still few. Therefore, more research is required in this area to assess students' acceptance of this technology.

Another important issue is the disparity of methodology in various studies, comprising the usage of original and altered models. A study found that despite the benefits and advantages gained by students via accepting the use of mobile technology and the provision of mobile education, the acceptance level remains comparatively low in some Arab countries (AlMulhem & Almaiah, 2019). Some researchers utilised the Mobile Learning Adoption Model and found that technological self-efficacy is a crucial element in encouraging students to accept M-learning (Almaiah et al., 2020). Furthermore, support within universities was identified as a key factor resulting in the success of mobile education among students, applying this type of education and taking advantage of its capabilities (Almaiah et al., 2016).

Several challenges have been documented regarding the technical and other aspects affecting users' interest and perception of M-learning technologies. Incorporating new technologies such as

M-learning should be supported with the community's acceptance before applying them (Lazhari & Sluiman, 2018). Alsswey and AlSamarraie (2019) emphasised that technical aspects could influence users' interest and perception towards victimisation of their devices in M-learning (Alsswey & AlSamarraie, 2019). Another challenge raised by Sönmez et al. (2018) is based on technological philosophical theory. Weakness in technical and infrastructure factors may impact negatively on students' acceptance and adoption of M-learning (Masrom & Hakemi, 2019). It has been established that no study considered the role of technical aspect when classifying the factors influencing the acceptance of M-learning and how they impact the knowledge gained by using the mobile technology (Bidin & Ziden, 2013). Therefore, in this study, an objective was raised to investigate the state of art of acceptance models and influencing factors in M-learning. Moreover, it has been long advocated to present a proposed model that includes the technical factors affecting students' acceptance of mobile technology in their learning. Additionally, guidelines in the form of a diagram needs to be developed based on the proposed model for successful application of mobile learning.

1.2 Problem Statement

The controversy of mobile learning over its importance has led to a recommendation for more investigations to be done on how it is to be implemented in education (Lazhari & Sluiman, 2018). Despite the immense benefits of mobile devices, there are limitations and weaknesses in applying them, especially in education. One of the important constraints is the poor acceptance of M-learning in some areas (Almaiah & Al Mulhem, 2019). This limitation has motivated and attracted the interest of many researchers to explore the underlying reasons.

In addition, students' acceptance of mobile learning nowadays is necessary to achieve success in their academic learning at educational institutions (Almaiah & Al Mulhem, 2019). Several studies have highlighted the importance of technical factors in order to achieve the vital benefits of M-learning (Alsswey & AlSamarraie, 2019; Sönmez et al., 2018; Masrom & Hakemi, 2019; Jinot, 2019). Moreover, technical aspects may influence the users' interest and perception towards using their devices in M-learning (Alsswey & AlSamarraie, 2019). One of the predictors of the success of M-learning is technological determinism (Sönmez et al., 2018). According to Masrom and Hakemi (2019), weaknesses in technical and infrastructure factors may negatively affect students' acceptance and adoption of M-learning.

The importance of technical aspects in the application of M-learning is clearly illustrated in developing countries. The success of M-learning may be limited in developing countries due to the high prevalence of technical constraints preventing students from optimising the application of this technology (Jinot, 2019). For mobile learning to be successfully applied among students, it is crucial to have effective and well-structured technical support (Sönmez et al., 2018). However, given that technical issues have a strong impact on M-learning (Fedirko, 2019), there is a need to elucidate the technical factors that could assist in enhancing the use of M-learning amongst learners (Wagner & Murphy-Hill, 2019). This is particularly true, especially in developing countries where technical issues relating to M-learning are evident.

These issues highlight the need to develop a model that measures the acceptance of M-learning amongst students based on the technical aspects, especially in the context of Arab countries. Arab nations are the countries in which the most spoken language is Arabic and they meet under the umbrella known as the League of Arab States, whether in Asia or Africa (Rauch & Kostyshak, 2009). Accordingly, this study aims to fill the knowledge gap by exploring and identifying the technical factors that could motivate learners to exploit the capabilities of mobile devices as a learning tool in higher education environment and produce guidelines for a successful application of mobile learning.

1.3 Research Objectives

1. To primarily identify technical factors that influence students' acceptance of technology in M-learning.
2. To develop a model to measure the students' acceptance of M-learning from the technical aspects.
3. To evaluate the develop model of acceptance of M-learning and produce a guideline based on the proposed model.

1.4 Research Questions

1 What , primarily, are technical factors that influence students' acceptance of mobile learning?

2 How to design and develop an M-learning acceptance model concerning technical factors?

3 How to evaluate these technical factors: device performance, compatibility, and support for varied protocols and platforms, connectivity and bandwidth, security and reliability, processing power, memory capacities, and measure their effects on a Saudi public university students' intention to use mobile learning?

4 How to formulate a guideline for successful application of mobile learning based on the proposed model?

1.5 Scope of the Study

Although M-learning systems offer several benefits to students, academic staff, and universities, the use and acceptance of the technology in some places are still very low (Almaiah, & Al Mulhem, 2019). The facilities related to technology acceptance models are present in several countries worldwide. However, there are limited facilities and reported studies in the context of developing countries in terms of adoption and use of technology, especially in the Arab region (Dajani & Yaseen, 2016).

This study focused on the development of a model that measures the acceptance of M-learning technology among a Saudi public university students of different age groups, ranging from 15 to 29 years old. This age group is comparable to that used in other countries, where students can enrol in colleges and universities at the age of 15 (Lyons, 2011).

The participants in this study were undergraduate and postgraduate students attending the University of Hail in the Kingdom of Saudi Arabia. The questionnaires were distributed electronically through the Information Technology Department at the University of Hail in order to reach a large number of students. This provided the opportunity to distribute the electronic questionnaires via email to recipients and register their interests to participate in the study. In addition, this procedure assisted to prevent repeated responses from the same participant. A total of 612 responses were received from recipients representing students enrolled at the university and from several professional and academic specialisations. A quantitative method was adopted in this study to develop the proposed model, whereas a questionnaire was designed to verify the model. Structural Equation Modelling (SEM) was used for a better interpretation of the proposed model's validity.

1.6 Definition of Terms

Several concepts related to mobile learning and the original model of student acceptance was used in this research. Furthermore, various definitions of technical factors were adopted in the model building process. These technical factors include device performance, compatibility, and support for varied protocols and platforms, connectivity and bandwidth, security and reliability, processing power, memory capacities.

Performance expectancy was defined as "the degree to which an individual believes that using the system will help him or her to attain gains in job performance" (Masrom & Hussein, 2008). For the purpose of the study, the definition was adopted, modified and redefined as the degree to which a student thinks that using mobile learning will increase the knowledge gained. According to the original UTAUT model regarding effort expectancy, it is defined as “the degree of ease associated with the use of the system" (Venkatesh et al., 2003).

In order to involve mobile technology in learning leads, effort expectancy was defined as the degree of ease associated with the use of mobile technology in the learning process. On the other hand, social influence is defined as "the degree to which an individual perceives that others believe he or she should use the new system" (Masrom & Hussein, 2008). According to the original definition of this factor, the researchers redefined it as the degree to which a student believes that the important surrounding community encourages the use of M-learning. Price has various meanings and uses according to different aspects. However, price could be "both an indicator of the amount of sacrifice needed to purchase a product and an indicator of the level of quality" (Dodds et al., 1991). Therefore, price was defined in this study as students’ belief that the value of mobile technology is reasonable for it to be used as a learning tool.

Connectivity is "a word used to describe how well hardware or software devices can communicate with a range of other devices" (Computer Hope, 2017). The learning process of using mobile technology can be defined as the ability to learn through mobile technology by communicating with several devices in different places. According to some researchers, "compatibility standards assure the user that a component or sub-system can be incorporated successfully and be 'inter-operable' with other constituents of a more extensive system of closely specified inputs and outputs" (David & Steinmueller, 1994). Under the proposed model, it was defined as the ability of the user to use the mobile device for learning through several platforms or programmes, regardless of the different sources. Mobile device security is defined as "the measures taken to protect sensitive data stored on portable devices" (Lerner, 2019). In this study, it was defined as the student's belief that data used for M-learning are protected and highly reliable. A processor can be described as "the electronic device which performs calculations" (Fred, 2014). In the proposed model, a mobile processor can accomplish calculation tasks that make learning through mobile technology easy and flexible.

Computer memory is "any physical device capable of storing information temporarily, like RAM (random access memory), or permanently, like ROM (read-only memory). Memory devices utilise integrated circuits and are used by operating systems, software, and hardware" (Computer Hope, 2017). Sufficient memory is vital for the benefits of mobile learning to be achieved (Coşkun & Tanrikulu, 2019). In this study, device memory was redefined as the ability of mobile technology to absorb, store, and transfer educational media of various sizes.

Performance is described as "the accomplishment of a given task measured against presently known standards of accuracy, completeness, cost, and speed" (Business Dictionary, 2020). By using mobile technology in education, device performance can be defined as the accomplishment of learning tasks through mobile devices in a specified period and time according to known standards.

The internet is defined as "a global network of networks used to exchange information using the TCP/IP protocol and allows for electronic mail, as well as accessing and retrieval of information from remote sources" (Fred, 2014). Here, network coverage was redefined as the ability to use mobile devices to access the network from several places for learning purposes. Network speed has been raised in numerous forums over the past few decades and has become a factor in driving a competition among communication companies. In this study, it was defined as the speed of communication via a mobile device (i.e., smartphone) and the time spent to execute the learning process, involving browsing, downloading and sending educational materials.

Table 1.1 Definition of Terms

Constructs	Definition
Performance Expectancy	The degree to which an individual believes that using the system will help him or her to attain gains in job performance (Venkatesh et al., 2003)
Effort Expectancy	The degree of ease associated with the use of the system (Venkatesh et al., 2003).
Social Influence	The degree to which an individual perceives that important others believe he or she should use the new system (Venkatesh et al., 2003).
Price Value	The perceived benefit of using technologies compared to the associated cost (Kumar & Bervell, 2019).
Connectivity	A word used to describe how well hardware or software devices can communicate with a range of other devices (Computer Hope, 2017).
Compatibility	Compatibility standards assure the user that a component or sub-system can successfully be incorporated and be 'inter-operable' with other constituents of a more extensive system of closely specified inputs and outputs (David & Steinmueller, 1994).
Mobile Device Security	The measures taken to protect sensitive data stored on portable devices (Lerner, 2019).
Processor	The electronic device which performs calculations (Mugivane, 2014).
Computer Memory	Any physical device capable of storing information temporarily or permanently. Memory devices utilise integrated circuits and are used by operating systems, software, and hardware (computer hope, 2017).
Performance	The accomplishment of a given task measured against presently known standards of accuracy, completeness, cost, and speed (Business Dictionary, 2020).
Internet	A global network of networks used to exchange information using the TCP/IP protocol. It allows for electronic mail and accessing and retrieval of information from remote sources (Mugivane, 2014)
Network Speed	The speed of communication via a mobile device (i.e. Smartphone) and how long it took to carry out the learning process that involved browsing, downloading, and sending educational materials.

1.7 Chapter Summary

This chapter contains an introduction to mobile education and the factors influencing the integration of M-learning in students' educational process. The introduction contains elementary concepts of mobile learning and their importance. Thereafter, several previous studies relating to the research topic were reviewed. In addition, this chapter also presented the research problem, the limitations of studies related to mobile education and the need to elucidate the factors affecting students' acceptance of mobile education. Although mobile education has existed for years, there is still a need to identify the factors affecting students' acceptance, especially with regard to technical factors. This knowledge gap is of utmost importance in the Arab region, where technical factors relating to mobile education are faced with several challenges.

This chapter also outlined the research objectives and questions in a clear and concise manner. Next, the scope of the study was summarised while highlighting the sample population to be studied to determine the effectiveness of the model to be developed in this research. The concepts used in this thesis were discussed in the introduction of itinerant learning and other concepts related to archetype, as well as the factors that were incorporated to form the proposed model in this study

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews previous studies on M-learning, its uses in education and development. During the years, education has moved through several stages and developments ranging from traditional education to the introduction of technology in education, the emergence of e-learning and its transition to other advanced stages. In the modern era, people are witnessing the emergence of a new way of delivering knowledge known as mobile learning. Mobile learning has helped to expand the access to education and knowledge. Also, the use of mobile phones eliminates the need for teachers and students to be in the same place.

This chapter also discuss the importance of previous studies in the field of M- learning, whether by the definitions given to this new type of education, its importance in terms of student development and providing students with knowledge in the easiest possible way. Moreover, mobile learning application is faced with several difficulties and constraints in developed and developing countries, therefore, affecting the achievement of the desired results. Furthermore, this chapter presents the acceptance models of technology, their developments and influencing factors as reported in previous research. A detailed focus on the most widely used and available theories in studies of behavioural acceptance of novel types of technology by individuals and students.

A review of the factors influencing the use of technology in education is discussed in this chapter. Next, the extent at which technical factors were included in the models of measuring the acceptance of technology among users of different types and cultures were highlighted. In addition, education in the Kingdom of Saudi Arabia was reviewed, including how the system is used, the beginning of education in the region and the spread throughout the Kingdom. Thereafter, this chapter reviews the education methods in the Kingdom of Saudi Arabia and the responsible authorities, educational management strategies and how students are guided from kindergarten to university levels. Education in the Kingdom is divided into several stages starting with the primary stage and ending with the university stage. All these services are provided by the Kingdom for the students to be motivated to seek education.

2.2 Education in Saudi Arabia

The Kingdom of Saudi Arabia undertakes a comprehensive care for public and higher education, and this is evidenced by the development in education that Saudi Arabia is witnessing at all levels (Kalila, 2001). Education in the Kingdom is based on the comprehensive Islamic system, which is considered as the basis for a broad system of life with the involvement of modern technology and its accompaniment in the Saudi educational system (Altaifi, 1988). Before the establishment of the Kingdom of Saudi Arabia, education was based on different cultures according to the prevailing political situation at that time. However, after the establishment of the Kingdom, the study life at the beginning of the Saudi era consisted of two different stages; each of which had a specified number of years Thereafter, it was later combined to become one stage and named the primary stage comprising of a term of six years (Abdul Hamid Hakim, 2012).

Among the commitments that the Kingdom of Saudi Arabia takes for its citizens is by providing all stages of education to all citizens in all parts of the Kingdom by delivering it to them in the best conditions and capabilities. This reflects the Saudi Arabia's view of science as a basis for the state's development and the way to advance the Kingdom and improve its rank among the developed countries (Editorial, 1998).

In the early days of its era, the Kingdom of Saudi Arabia faced several obstacles that prevented the spread of education (Abdul Hamid Hakim, 2012), Among these difficulties were;

1- Financial weakness capabilities before the discovery of oil with the expansion of the geographical scope.
2- The societal opposition for education, as ignorance was widespread before the establishment of the Kingdom, which generated opposition to some types of education from certain categories of society.
3- The acute shortage of basic elements for establishing schools and spreading knowledge, such as the availability of teachers, buildings, books, and school equipment.

Saudi Arabia were able to overcome all of these obstacles through the passage of time and after the discovery of oil. As the material income of the state increased, the Bedouins who were constantly migrating eventually settled in fixed places. Henceforth, they could benefit from education and this was accompanied by the use of methods that led to societal acceptance of education (Abdul Hamid Hakim, 2012). This was augmented by societies in different countries of the world paying more attention to education. Necessary spending focusing on education is performed to the fullest extent and from this standpoint, the Kingdom of Saudi Arabia, like other countries, pays special attention to education at all stages (Kalila, 2001).

Although the Kingdom of Saudi Arabia is considered as one of the relatively modern countries and its public education has not existed for long decades, there has been a great demand for it by its citizens. This is mainly attributed to the fact that the state provides free education for everyone.

In addition, at the beginning of education in Saudi Arabia, the state increased the income through several academic requirements for students to encourage them to study and engage in education (Altaifi, 1988). All these functions were carried out by the authorities responsible for education in Saudi Arabia in order to overcome all obstacles that prevent knowledge from reaching its citizens. These actions were taken to ensure that the education process contributes to the country's advancement and development (Abdul Hamid Hakim, 2012). The Kingdom of Saudi Arabia was the first Arab country to adopt free education at all levels, provide modern buildings, and a healthy environment for its students to study smoothly (Editorial, 1998).

Another important aspect is the supervision of education, which has been reinstated in the provision of education at all levels in the Kingdom of Saudi Arabia. The task of supervising education in the Kingdom is executed by several official agencies and authorities (Abdul Hamid Hakim, 2012), and among these are:

1 - The Supreme Committee for Education Policy: The task of this organisation is to formulate education policies.

2- The Ministry of Education: It was called the Ministry of Alm'arf (Education) in the past, and considered one of the oldest institutions that is responsible for education in Saudi Arabia and various educational stages in general (i.e., higher institutions and teacher training colleges).

3- The General Administration of Girls Education: This body was established in the 1960s and it is responsible for girls' education. Recently, it was merged with the Ministry of Education and became a single entity.

4- The Ministry of Higher Education: This ministry was established in 1975 and its mission is to supervise, set programmes and plans for universities and higher education institutions.
5- Technical and Vocational Training Corporation: This institution used to be supervised in the past by the Ministry of Education (Ministry of Alm'arf) and the Ministry of Labour and Social Affairs. Its mission was to prepare and train people to meet the needs of the labour market in Saudi Arabia. Subsequently, the institution became an independent and separate entity from the Ministry of Education and the Ministry of Labour. Presently, the institution has its own budget to set up plans and programmes, such as preparing the technical and professional forces to meet the labour market requirements of technical and professional competencies.
6- There are other authorities that engage in partial supervision of education in the Kingdom. For instance, only personnel from the Ministry of Health are responsible in supervising health colleges and institutes, whereas the Ministry of Defence and other ministries that have educational institutions affiliated to them in order to train students to meet the needs of these ministries..

2.2.1 Education Systems

There are several stages of education in the Kingdom of Saudi Arabia through which students pass from general education to higher education, with other institutions and schools being optional for students, such as technical, professional, military and other institutes. The first of these stages is the kindergarten level, then the primary level, followed by the primary level, intermediate level, secondary school level, and the university level and higher education in that order. These stages of education are provided free of charge to the students based on the provision of the means being assigned to them in these stages (Editorial, 1998). The period of study at the primary, intermediate and secondary stages is six years, three years, and three years, respectively. In the secondary stage, the students have the right to choose the appropriate path for themselves based on the four available tracks that they could choose from (Abdul Hamid Hakim, 2012). These tracks include the following;

1- Department of Natural Sciences.
2- Department of Sharia Sciences.
3- Department of Administrative and Social Sciences.
4- Department of Applied Sciences.

These departments allow students to prepare appropriately for higher education, which they will be transferred to after high school. The educational policy is the general directives and guidelines that underpin the educational process in order to prepare individuals and introduce them to moral, scientific, and educational basics to enable them participate effectively in the society (Saudi Ministry of Education, 1995). The education policy in the Kingdom of Saudi Arabia was officially issued in 1971 and contained many articles that exceeded two hundred items. It also contained the goals and principles that Saudi Arabia is following in its educational curriculum (Abdul Hamid Hakim, 2012). These principles are generally based on the following aspects:

1- The Faith Principle: Saudi Arabia is keen on caring for the faithful side of students that stems from the Islamic faith, which is evident in the given time allocated to religious lessons in the school curriculum.
2- The Humanitarian Principle: The educational policy stipulates preserving the dignity of individuals and their human rights, whether they are teachers or students, and this comes from the Islamic Sharia which the Kingdom takes as a basis.

3- The Principle of Justice and Equality in Educational Opportunities: The Kingdom of Saudi Arabia provides educational opportunities for all of its citizens, irrespective of gender or stages of education, so that everyone can develop the country and bring it to the level of progress and prosperity.

4- The Development Principle: The Kingdom takes care of education because it is one of the foundations that drive the wheel of development and prosperity. Therefore, the higher the financial income returns to the state, the higher the interest in development projects related to education.

5- The scientific principle: The Kingdom pays attention to new developments in various sciences and is keen on drawing from all new and useful sciences. This comes with the increasing openness towards other cultures in the world in order to make Saudi Arabia be alongside the developed countries while concurrently preserving its Islamic identity.

6- The Principle of Education for Work: the educational policy included focusing on the importance of work and linking this with the learners and urging them to do so because of its tangible impact on individuals' lives, citizens' well-being and the development of civilisation.

7- The Principle of Education for Strength and Building: The educational policy is keen to include articles calling for strength from its positive concept that builds the nation and urges social solidarity among its children so that learners can carry the message entrusted to them.

8- The Principle of Continuous Integrated Education: it is intended to comprehensively consider what surrounds the nation and the complementarity between human, the universe and life, as well as urge the integration of individuals, whether males or females, with its continuity.

9- The Principle of Originality and Innovation: The Saudi educational policy urges benefitting from the new useful knowledge present in human culture without clashing with the faith and inherent heritage of the country's civilisation to achieve the desired goals of education.

10- The Principle of Education for Life: the educational policy links the learners with the comprehensive Islamic vision of life, the universe, and human beings so that everyone can perform the tasks assigned to them without obstacles.

2.2.2 Hail University

The Kingdom of Saudi Arabia focused on higher education due to its close connection with the country's development. As children in the past were deprived of education, this has heightened the interest of those responsible for the education sector in higher education, leading to the establishment of many universities, institutes and technical colleges (Kalila, 2001). Saudi Arabia used to send its citizens to institutions abroad to meet the needs of scientific and academic competencies. However, with the development in the field of higher education, Saudi Arabia has been attracting scholarships from other countries to study in its multiple universities (Editorial, 1998). In a study conducted on a sample of students at the University of Hail to assess their perception of mobile learning, the results showed that females and males realise the importance of mobile learning (Aldossary & Zaid, 2016).

The universities established in Saudi Arabia have participated in the development of society and meeting its knowledge and human needs (Al-Ohali & Abdul Qadir, 2010). Among these universities is the University of Hail which was established in 2005 (University of Hail, 2020).

The university was established in order to serve multiple categories of the Saudi society. The university took its name from its distinct geographical location in the city of Hail. Among the goals that the University of Hail aspires and seeks are to be distinguished in the scientific and research fields and to be at the forefront of the leading universities in the region (Emtyiaz corporation, 2020).

The university is located in the northern region of the Kingdom of Saudi Arabia and is distinguished for having a deanship for e-learning since its inception (Alharbi et al., 2017). It contains many colleges, namely: College of Medicine, College of Dentistry, College of Pharmacy, College of Applied Medical Sciences, College of Public Health and Health Informatics, College of Nursing, College of Computer Science and Engineering, College of Engineering, College of Science, College of Education, College of Arts and Arts, College Sharia and Law, Community College, and College of Business Administration in addition to a number of supporting deanships (University of Hail, 2020).

Moreover, the university has a preparatory year programme to qualify new students at the university and direct them towards the appropriate majors. There is also a bridging programme for diploma students to help them complete their education (Emtyiaz corporation, 2020). The university has thousands of students in various educational programmes, and large number of faculty members. It provides a number of scientific chairs in various research fields (University of Hail, 2020).

2.3 Technology in Education

The improvements relating to communication technology rely on mobile networks, which are among the key developments in modern society. This is evidenced in the high number of phones used worldwide, which is presently estimated as two billion (Tamilarasan et al., 2019). The use of phones was considered a luxury in the past; however, it is now regarded as a main feature of general life. Currently, the reliance on using mobile phones as learning tools has increased, which suggests that there are influential factors linked to mobile use for educational achievement.

In the last decade, mobile phone technology has progressed at a significant rate with numerous achievements and range of services. The use mobile devices among students in their daily activities is expected to interfere with the way they receive educational materials (Carol Campbell, 2018). Smartphones are widespread and they are used for various purposes and different situations (Collins et al., 2019). The increasing usage of mobile phones for multidimensional tasks match the rising number of the users globally. Presently, the use of the internet is virtually a global commonplace as it has become a necessity of life and distributed throughout different cultures. In evaluating the technological advances of this era, the increased use of the internet is aligned with the rising number of mobile devices, as well as the use of mobile applications.

Mobile phone technology can provide the users with complete sets of videos or audio tools which are available for general consumption. In addition, a 3G service enables the users to access several features, such as the internet and the capacity to download audio and video files. Mobile technology is not currently limited to education, but extends to many fields, including tourism and hospitality (Tu & Hwang, 2020). Mobile devices allow the users to connect to Wi-Fi networks, however, the speed and number of users associated with the same network may be affected. This shows that a greater number of network users may lead to reductions in speed (Wentzel et al., 2005).

The fourth generation (4G) of communication technology increases the effectiveness of special services and multiple videos through wireless networks and media. Joint international actions on 4G technology have resulted in several developments in terms of speed, performance, reliability, fault tolerance, portability, interoperability and latency in real-time applications. 4G also provides safe and easy access at the same time (Adibi, 2010). Service contributions by fourth-generation multi-technology include higher connection speeds, a wider network spectrum, more flexibility in communications and a better viewing of visual channels (Bai et al., 2012). These improvements in the service have certainly led to more effective applications for M-learning.

Effective and influential learning can be approached as a process. Firstly, this includes creating the possibility of active learning by allowing students to learn at any time or location. Secondly, cooperation and teamwork among students should be facilitated by providing functions, such as virtual collaboration. Thirdly, learning develops through simplification of teamwork and joint ventures. Fourthly, information and knowledge can be provided from realistic sources (Sheng et al., 2010). The development of mobile phone technology has led to greater versatility, ease of use, and cost-effectiveness. Therefore, it can provide content for educational purposes and facilitate learning in addition to providing personal contact with others, referred to as the World Social (Zhao et al., 2009). Research has found that the basis for the success of an educational process is placing the learning responsibility in the students' hands (Male & Pattinson, 2011). Meanwhile, technology is developing and changing many aspects of human society (Hwang & Fu, 2020).

Despite various studies have been conducted on mobile learning, scholarly analysis largely continues to be directed towards the angle of M-learning (Taha, 2020). Illuminating this finding can provide a greater understanding of this type of technology and its applications (Lazhari & Sluiman, 2018). Similarly, despite all the advantages provided by mobile devices, there is still a weakness in terms of the low acceptance in some areas (Almaiah & Al Mulhem, 2019). This reality has motivated and attracted the interests of many researchers to explore the underlying causes.

The reasons for the low acceptance of mobile technology in education may be attributed to the interplay between technical and non-technical factors. Technical factors means that factors which are related to technical difficulties affecting mobile learning, such as memory and connectivity. On the other hand, non-technical factors are considered the general events that affect students, including social influence and price value. Some instructional authorities have adopted and employed M-learning in universities although obstacles have prevented students from using mobile devices in certain applications and activities (Kayode et al., 2019). These obstacles could be associated with technical and non-technical factors like device capabilities, network coverage, facilitating conditions or social influence (Almaiah et al., 2016).

The importance of M-learning in educational settings has been documented in several studies. Student acceptance of the current new form of instructional learning technology is vital in realising future success in certain aspects of their learning in instructional establishments, such as tutorials (Almaiah & Al Mulhem, 2019). A study found that about 95% of students supported the use of mobile phones to communicate with classmates and teachers as it is faster than traditional methods (Adeboye, 2016). In addition, many scientific voices urged further studies on student attitudes to learning when using phones (Ibrahim et al., 2017). However, a previous study claimed that mobile learning is still considered a supplementary method that can assist students in learning, but not operate as a full learning process. Likewise, the author concluded that mobile learning lacks the capacity to assume a teacher's role due to its technical limitations and inability to replicate human nature (Wang & Higgins, 2006). This highlights the potential challenges in involving mobile technology in the learning process in developing countries. Technical challenges remain one of the most important issue faced by developing countries in M-learning (Oyelere et al., 2016).

For instance, mobile learning users may encounter difficulties in using this technology when they travel abroad if their destination countries do not follow the same technical standards (Wang & Higgins, 2006). Due to weaknesses of the technology substructure in Africa, there were challenges in inserting M-learning in postgraduates' curriculum (Kaliisa & Picard, 2017). However, current advancements in the telecommunications sector are helping to serve the community in many ways. This is evident by the number of subscribers to these services over the past few years (ITU, 2014).

The use of mobile devices, such as smartphones has become an essential, if not a luxury item and accessory for many users in performing a vast array of tasks and functions. Historically, mobile devices and associated technology continue to develop exponentially, helping users to complete tasks quickly, perform transactions, as well as access the internet to find information and for entertainment (Almaiah et al., 2016). Cell phones were being used almost everywhere, with users becoming more attached to these devices for work, communication and pleasure (El-Masri & Tarhini, 2017). Given the growth of this technology, the use of the internet has become commonplace in the lives of people worldwide; not just to communicate, but also to watch video broadcasts and make video calls. However, the quality of such applications may be affected by the number of people connected to the mobile network (Wentzel, 2005).

Indeed, at present, the use of fifth-generation networks such as 5G is emerging. They are driven by previous generations of networks that enhanced the adoption and growth in the use of mobile devices such as smartphones. For instance, in fourth-generation networks such as 4G, notable developments and advancements were made in numerous domains, including multimedia, video broadcasting, data transmission, and security in reaching users in different parts of the globe through various types of devices (Arshad et al., 2010).

2.3.1 E- Learning

In the past, education was limited to well-known educational methods in which the teacher was at the centre of the educational process from which students received knowledge. These methods changed with the dawn of the internet and developments in the field of computers and information, leading to the emergence of new forms and patterns of the educational process known as e-learning (Al-Mazhar, 2006). At the time, this modern technology was defined in different ways in many studies. E-learning is a new method of learning based on the use of electronic technologies, whether computer, internet, electronic library, or e-book in order to communicate information without requiring the teacher and student to be in the same place (Hamida, 2015). In addition, many other definitions of e-learning have emerged with the use of modern internet and communication technologies to build and present the educational process to learners at any time and place (Kafi, 2009). E-learning can also be defined as the educational process based on the use of internet services (Kafi, 2009). All these definitions revolve around the inclusion of the internet and computers in the educational process in several different ways through which information can be communicated to the student without restriction of a specific place or time. -learning has gone through several stages of its emergence until the present time, however, it can be broadly reduced to two stages (Hashem, 2017):

1- The first phase is between 1993 and 2000, in which the internet appeared and the use of electronic means to display files such as audios, images, and videos.

2- The second phase is between 2001 and the present time following the emergence of generations of communications emerged, developed methods of creating websites, and increased the speed of completion.

After its emergence, the internet contributed to the delivery of knowledge and information to the recipients by providing a base and huge library of information that can be accessed from anywhere. Previously, students used to receive knowledge and educational materials in a small classroom (Al-Mazhar, 2006); nevertheless, many tools have been developed and used in the e-learning educational process (Hashem, 2017). Examples of such tools are as follows:

1- Conversation programmes: Through which a group of experts and specialists can communicate with students, interact with them, and manage dialogues and discussions through dedicated rooms in the internet.

2- Video conferences over the internet: where conferences and meetings are held between a number of individuals to share information and knowledge without the need to be in a specific geographical location. It is through the use of television networks that the internet is accredited on in order to create dialogues between individuals and manage conversations between them.

3- Voice conferences: Voice meetings between individuals are held through the use of the internet and a telephone in order to reach the speaker (whether a teacher, lecturer, or other speaker) with the recipient, whether he/she is a student in school, university or other entities.

4- E-mails: This is a way for the teacher to send lessons and information to students without having to be together at the same time. The students can open the mail at any time, browse the information and incoming messages, and can then send a review of the educational materials, or write questions he wishes to ask the teacher. The advantage of this method arises as the direct presence of the teacher and the student is required at the same time while the teacher can also send scientific materials to many students simultaneously without involving high cost of materials or using many papers.

5- Web pages: there are two types of web pages namely the static and interactive web pages. The static web page contains information but it cannot be interacted with and the role of the student is limited to reading. Interactive web pages permit the student to interact with the web page by answering questions. The student can choose or write answers to a number of questions on the website or ask for help and other benefits.

6. Mailing lists: A group of persons can participate in a particular list that sends them messages periodically based on pre-defined topics, whether they are specialised in technology or other scientific subjects. Through this method, the student can participate in the appropriate lists so that he or she can gain knowledge in a specific or diverse field.

7- Discussion groups: There is a moderator or coordinator who is responsible for supervising the debaters, distributing discussion opportunities among them and urging them to participate actively in the panel discussion.

8. CDs: These compact discs contain the curriculum that a student can use on his or her personal computer at home or at school. This technology has evolved and increased its interaction over time to include educational videos and audios, as well as the presentation of books and scientific references in various fields.

After the advent of e-learning, many countries have implemented the technology in their educational process to deliver knowledge to the largest possible segment of learners and to increase their educational attainment (Hamida, 2015). According to Kafi (2009), there are numerous obstacles and difficulties in the application of e-learning and examples are summarised as follows:

1- Developing standards. Science is developing continuously and rapidly so this may affect e-learning like the use of CDs in which the content might be difficult to change.

2- Privacy and confidentiality. Hacks and attacks on websites raise concerns among teachers and educators about the potential impacts on the e-learning process.

3- There is an expected interaction between students with this technology.

4- There is a need for real-time training and continuous updates of students and administrators due to the rapid development of technology.

In addition, there are also some general difficulties faced by various countries, particularly in the Arab region, such as the lack of technology infrastructure and the protection of intellectual rights to electronic publishing (Hamida, 2015). These difficulties are accompanied by errors in the application of e-learning, such as the lack of clear plans, a focus on financial returns, and the belief that e-learning is a complete alternative to the teachers (Kafi, 2009).

2.3.2 Mobile Learning

With the inception of mobile learning (M-learning) innovation and its presentation in the field of instruction, its numerous components within learning procedures have been recognised. The instructor is no longer the main source of data for undergraduates. The inclusion of cell phones into the instruction framework is among the components of M-learning that has been utilised in recent times. Certain definitions that clarify this innovation have been noted by numerous scientists. Portable realising, popularly known as M-learning, is the conveyance of any instructive substance to the beneficiary that is created and utilised by cell phones, regardless of whether it is explicit data or a full educational programme (Xyleme, 2019). Some researchers showed that the basic positive features of the technology reported by undergraduates were versatility and convenience, which are the principal foundation of M-learning (Abu-Al-Aish & Love, 2013). Nothwitstanding the advancements made in intelligent gadgets, versatile training is still considered an auxiliary strategy for discovery, which merely assists understudies to collect data. Meanwhile, the role of the human educator remains essential because of social and specialised competencies (Arshad et al., 2010).

Despite this reality, some previous studies found that numerous undergraduates want to utilise cell phones because it facilitates correspondence with their educators and associates more than any other conventional strategies now accessible (Wang & Higgins, 2006). Versatile learning also makes training procedures more satisfactory, particularly among youngsters who are bound to seek innovation and have an enthusiasm for it (Gedik et al., 2012). Furthermore, portable learning permits students to study alone without the requirement for an educator, which simultaneously builds cooperation between classmates (Ng et al., 2013). Besides, it is not necessary to do this activity in a similar spot (Nguyen et al., 2014). Thus, it has been noticed that college undergraduates generally utilise their cell phones to speak with one another without having perceptible issues using phones in the learning procedure (Mahat et al., 2012). Moreover, portable learning permits students to benefit as much as possible from their contribution of time (Liu et al., 2010). It is currently not mandatory to obtain data simply in lecture halls; however, there is a need to recognise mobile phones as the means of exchanging information from anywhere on the planet at a reasonable cost (Lazhari & Sluiman, 2018). Recently, some researchers and educational personnel have used games based on mobile technology in the educational process (Chang &

Hwang, 2019). Some researchers have found that self-learning through mobile phones can be a major vehicle for student development (Chung et al., 2019).

Although certain aspects of education require the utilisation of portable learning, a key consideration remains that certain factors may influence this type of instructive procedure. The student, through cell phones, may confront a few issues while moving between one nation and the next as the specialised standards may vary between the two nations (Arshad et al., 2010). Although massive developments have been made in mobile learning, there remains a need to involve M-learning studies in Physical Education (Yang et al., 2020). At the point when versatile learning is added to the training procedure in developing nations, clients may experience challenges in its application, i.e., one of these being specialised issues that may emerge for the students (Ibrahim et al., 2017). Additionally, some instructive materials are created for use with work area gadgets or workstations which may not be suitable for smart gadgets or telephones utilised by students, except if they incorporated certain changes that make them usable in the two places (Little, 2013). This issue has recently been resolved with numerous instructive stages for supporting work area views and versatile views. Presently, it has become possible to use the mobile phone for learning at any time or location (Hwang et al., 2020).

Mobile technology allows anyone to access media files that are usually found on websites. A 3G service offers individuals the chance to use the internet in many locations. It can be connected to Wi-Fi networks and the speed may vary based on the number of network users (Abachi & Muhammad, 2013). Students like to use mobile technology as a learning tool but this is combined with their scepticism toward security and coverage issues (Abachi & Muhammad, 2013). Mobile learning is not bound by any specific location, but can be followed anywhere (Adibi, 2010).

Half of the world's population can access the 4G network and 84% can use 3G. The number of mobile users has reached five billion and about three-quarters of them can use the internet. These huge numbers have been achieved by the continuous advancement in mobile infrastructure which is conducted by mobile companies (Kaliisa & Picard, 2017). China Internet Network Information Centre issued a report stating that as of June 2010, the number of people who used the internet amounted to 420 million (Bai et al., 2012). Education authorities must change their approach to the education process to keep it efficient and create a space for competition (Bidin & Ziden, 2013).

Providing coverage of mobile and Wi-Fi services on trains is not easy (Gueorguiev, 2017). Therefore, it is necessary to consider this while evaluating the use of mobile devices as learning tools while the learner is moving. Although the screen size of mobile devices has developed, people may find it annoying to use a device for learning, especially in noisy environments. Mobile device designs normally concentrate on providing a few learning services (Bai et al., 2012). Many difficulties may arise from applying M-learning, most of which are related to the characteristics of the mobile device, while the remainder is generally linked to user expectations of this technology (Bidin & Ziden, 2013). In almost no cases have studies illuminated technical factors that affect M-learning (Bidin & Ziden, 2013).

Mobile learning offers suitable opportunities for individuals looking to acquire new knowledge. Those who through the use of mobile devices, a good network with good software and equipment, can get many benefits in the educational process (Hamidi & Chavoshi, 2018). There is a strong relationship between the culture of peoples and their acceptance of this type of education (Arpaci, 2014). For this reason, there is an urgent need to learn some aspects of mobile learning. There are a number of aspects that scientists can develop mobile learning, i.e., from taking into account when designing this type of education so that it is useful and effective for students and learners, including these aspects (Marguerite, 2009):

1- The characteristics of the device: There are a number of things related to the device, whether technical, physical, or functional. These aspects are important to the users and may lead to comfort when using the device in the educational field. One of these aspects is the physical aspect, which is related to weight, size, and suitability of keys for use whether right or left hand and so on. Additionally, there are also some features such as screen, memory, audio, processor, and others. These characteristics, if good and appropriate, have an important impact on the use of the device in the educational process.

2- Characteristics of the learner: This aspect describes the ways in which the user deals with the device to gain knowledge through what has been learned in advance and how to deal with data either through transfer or storage. Mobile learning helps improve data handling by allowing users to access content in many different ways.

3. Social aspect: This aspect focuses on how individuals interact to obtain information and knowledge governed by social norms that exist in the society in which learners are living. It is important to know these rules and limitations to reach good interaction and communication between learners.

The role played by universities and some M-learning officials is critical in motivating students and making them aware of the many benefits that this type of education offers (Abu-Al-Aish & Love, 2013). In recent years, there has been a steady rise of interest in M-learning and adoption by university students (Hashim et al., 2015). M-learning is an effective means of communicating information and knowledge and one of the various teaching methods that should be understood and promoted to a group of learners (Hashim et al., 2015). Extensive research is being conducted on mobile learning while interested parties believe that it offers many advantages to learners, either from data access and communication with systems and people (Marguerite, 2009). In the same vein, the use and benefits of M-learning systems improve education management by developing the learning process and increasing student desire in such technology (Abu-Al-Aish & Love, 2013).

The vital and obvious difference between M-learning and e-learning is that students can use the former and access information through their devices at anytime, anywhere, without having to be in a specific location or linked to a personal computer (Hamidi & Chavoshi, 2018). The trend to adopt M-learning from the desired things at the moment is due to the diverse services and advantages offered by the technology (Arpaci, 2014).

The use of M-learning and its introduction into the curriculum of university students has changed the way information is delivered to the beneficiary. This had led to the emergence of challenges and benefits that accompanied this technique (Marinakou & Giousmpasoglou, 2015). In addition, there are limited studies on M-learning and its benefits, as well as the perception of users (students and teachers) about the technology (Singh et al., 2016). Developers need to consider several factors and use different strategies to reach learners and deliver knowledge to them seamlessly anywhere (Yu et al., 2015). These considerations are pertinent in order to change the way of learning from old methods such as traditional process or e-learning to M-learning.

Despite developments in e-learning, M-learning in some Arab countries and Gulf Arab countries is still seen as a not-so-essential educational method and one of the modern prevalent methods prevalent (Marinakou & Giousmpasoglou, 2015). Mobile learning users around the world differ in how they benefit from M-learning. Some benefit significantly from the potential benefits of the technology, whereas others only gain a little (Al-Shehri, 2016). M-learning is a potential environment to be used in education, however, its usage for the sole delivery of educational materials may not necessarily translate to the expected targets (Yu et al., 2015). Mobile learning users still have difficulties with the technical skills. They have to deal with mobile devices in order to use them to gain knowledge as well as certain constraints in choosing the right type of educational materials and resources (Djoub, 2015).

The increase in the number of mobile devices of various types has changed the concept of technology-related education. This has led to the development of student achievement, which is one of the important objectives of the educational process (Tamilarasan et al., 2019). Nevertheless, this does not mean that it can be applied directly without examining the concurrent difficulties and challenges of learners and teachers. Due to the novelty of M-learning and its inception, the users are faced with certain challenges and difficulties as outlined below:

1. Restrictions imposed on M-learning devices, the policies, and the infrastructure in which this type of education is provided by some institutions (Singh et al., 2016).

2. The novelty and use of M-learning are still in their early stages in some countries, such as some Arab countries. Therefore, it is difficult to draw the desired conclusions from this experience at the moment (Al-Shehri, 2016).

3. Many people who use mobile devices may not use them to learn as they move from one place to another during their lifetime (a key feature of mobile learning). However, they may use them for entertainment and when they arrive at home, they may prefer to use them for other means, such as computers (Wang & Higgins, 2005).

4. Some Arab students believe that M-learning is a luxurious way to obtain information and is not necessary (Wang & Higgins, 2005).

There are several technical problems associated with the inclusion of M-learning in educational science. One of these problems is the display screen, its accuracy used in mobile devices, data entry methods and limited internet access, with many web pages containing various information and data. This information are viewed and browsed through mobile phones in different ways, leading to the loss of vital information. In addition, there are specific difficulties in terms of compatibility and standards between different mobile platforms (Wang & Higgins, 2005).

2.4 Models of Acceptance

Numerous models have recently been developed that measure innovation acknowledgment by clients. These models have been examined and evaluated in recent years. Among the most famous and generally utilised models is the Technology Acceptance Model (TAM) which was conceived in 1989. Meanwhile, the Unified Theory of Acceptance and Use of Technology (UTAUT) was presented by Venkatesh et al. in 2003 (Dajani & Yaseen, 2016) and created to quantify the social aspect of a client's demeanour toward PCs (Davis et al., 1989). Following the examination by analysts, the model indicated several uses which were modified based on the researchers' perspectives. Furthermore, TAM has been undergone various examinations and explorations to gauge clients' acknowledgment of the consideration of innovation within the instructive procedure. However, most of these investigations revolved around the instructor (Courtois et al., 2014).

Many studies in recent years have focused on measuring the acceptance of technology among learners. One of the most widely known models is the UTAUT (Magsamen-Conrad, Upadhyaya, Joa, and Dowd, 2015) and the model was developed by Venkatesh et al. (2003) based on eight theories: the Theory of Reasoned Action (TRA) outlined by Davis et al., 1989; the Technology Acceptance Model (TAM) published by Davis in 1989, and Venkatesh and Davis in 2000; the Motivation Model (MM) by Davis, Bagozzi, and Warshaw presented in 1992; the Theory of Planned Behaviour (TPB) by Taylor and Todd which was published in 1995; the Combined TAM and TPB (C-TAM-TPB) by Taylor and Todd produced in 1995; the Model of PC Utilisation (MPCU) by Thompson, Higgins, and Howell in 1991; the Innovation Diffusion Theory (IDT) by Moore and Benbasat developed in 1991; and the Social Cognitive Theory (SCT) by Compeau and Higgins presented in 1995, and by Compeau, Higgins, and Huff in 1999 (Magsamen-Conrad et al., 2015).

The TRA, TAM and TPB have been involved in several studies measuring the acceptance of technology in learning, but most of these investigations revolved around the teacher (Courtois et al., 2014). The TAM has adopted the TRA relating to IS (Mohammadi, 2015). The TAM was developed only to measure behaviour regarding computer use (Davis et al., 1989). User intentions to employ computers in their jobs are affected by the extent to which it can benefit their work performance (Davis et al., 1992). Certain factors affect a student's intention to use the mobile phone as a learning tool, which are cognitive, affective, and social needs by means of attitude (Hashim et al., 2014). The TAM is a useful measurement tool but it needs to be adapted to contemporary changes (Legris et al., 2003).

The investigation into how the perceived features of innovations react with each other can assist in building a general theory (Moore & Benbasat, 1991). One study used a modified model of the TAM and found that attitude was the key construct to interpret the cause (Park et al., 2011). Information system adoption is influenced by 'trust' which raises willingness to use it (Venkatesh et al., 2011). Prediction of learners' online learning satisfaction is generated by online learning self-efficacy (Shen et al., 2013).

Another dimension that has been measured in previous studies is users' perceptions of technology. The TAM and UTAUT represent the most recognised and frequently used models. The TAM was developed to measure only behaviour related to computer use (Davis et al., 1989), whereas the UTAUT was established based on eight theories to measure technology acceptance. However, no studies discussed the technical aspect as a vehicle for imparting knowledge through M-learning (Bidin & Ziden, 2013).

Mobile phones have been largely used in modern life with the most recent being in the education field, which is commonly known as M-learning. As a result, developers of educational mobile applications need to know the needs of users that satisfy their use of such applications. Many models have been conducted to measure the satisfaction of using mobiles as a learning tool using the Unified Theory. Nearly none of these models has focused on the technical factors that affect the users' intentions to use their mobile as a learning tool. This research investigated these factors in-depth and came up with an adopted model of the UTAUT.

Mobile phones have become widespread in the modern era. One contemporary use of mobile phones is in the education field. Following the growth of M-learning, developers of educational mobile applications need to know what the user requirements are, and how to satisfy them. In order to measure user satisfaction while engaging with mobiles as learning tools, many models have been created using UTAUT and other models, such as the Technology Acceptance Model (TAM). However, a nearly limited number of these models have focused on the technical factors affecting the users' intentions to use their mobile phones as learning tools. Table 2.1 shows a well-known acceptance models.

Table 2.1 Well Known Acceptance Models

Model	Developers	Domain	Constructs
TAM	Davis et al. (1989)	acceptance of the computer	Perceived Usefulness (PU) and Perceived Ease-of-Use (PEOU)
TPB	Ajzen (1985)	extension of TRA	extension of TRA theory by adding a perceived behavioural control
TRA	Fishbein and Ajzen (1975)	psychosocial aspect	intentional behaviours and relationships between beliefs, attitudes, norms and behavioural intentions
UTAUT	Venkatesh et al. (2003)	acceptance is to new technologies	Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating conditions

2.4.1 The Unified Theory of Acceptance and Use of Technology (UTAUT)

This model is a useful tool that helps decision-makers to see how users' acceptance is to new technologies and know the factors that affect them (Venkatesh et al., 2003). This model consists of four main factors that influence individuals' intention to use technology and these factors are Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating conditions (Venkatesh et al., 2012). These factors are associated with certain moderators, such as age and experience which affect the strength of the effect of these factors (Venkatesh et al., 2003).

The definition of these factors varies depending on their use in many areas where the original definition was adopted and then changed to match the topic being studied. According to Venkatesh (2003), these factors can be defined as follows (Khechine et al., 2016):

1. Performance Expectancy (PE): The degree to which an individual believes that the use of technology will increase the opportunities through which he or she can increase his or her career gains.

2. Effort Expectancy (EE): It is intended to be the degree to which users think it easy to handle modern technology that practitioners will use for the system.

3. Social Influence (SI): It means the extent of others' influence to induce individuals to use the new system or technology.

4- Facilitating Conditions (FC): It means the degree to which the users believe there is an infrastructure that supports them when they want to use the new system or technology.

UTAUT is one of the most popular models being widely used around the world to measure individual acceptance of new technologies. Its validity has been confirmed in many aspects of information systems applied in different places around the world (Alharbi, 2014). In addition, in some studies, UTAUT has been shown to be suitable for use in several different cultures (Nistor et al., 2014). After studying many of the scientific articles published in this field, UTAUT has been reported to be the most capable model with the predictability of individual acceptance of technology and the expected effectiveness of this use through the factors and influences presented by this model (Khechine et al., 2016). Figure 2.1shows UTAUT model developed by (Venkatesh et al.,2003)

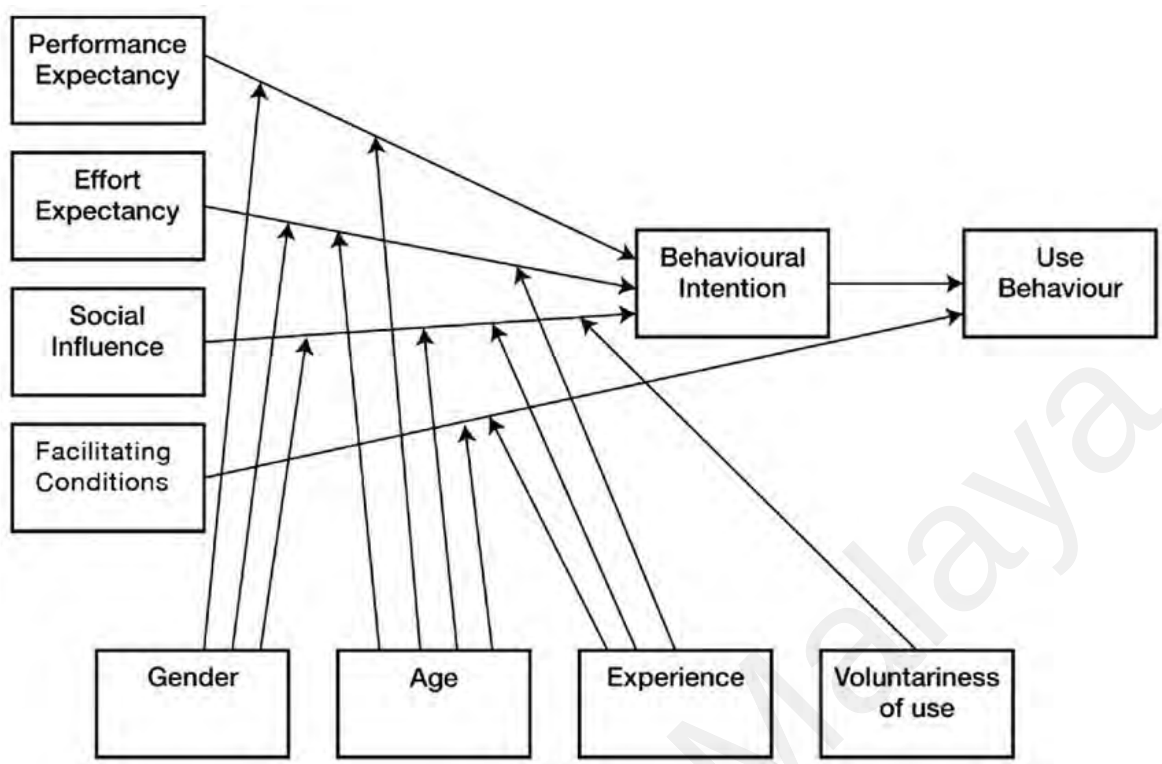

Figure 2.1 UTAUT Model by Venkatesh (2003)

2.4.2 Technology Acceptance Model (TAM)

Numerous models have recently been developed that measure innovation acknowledgement by clients. These models have been examined and evaluated in recent years. Among the most famous and generally utilised models is the Technology Acceptance Model (TAM) which was conceived in 1989 as shown in Figure 2.2. TAM is one of the models used to study user acceptance of the computer by examining the effect of two factors: Perceived Usefulness (PU) and Perceived Ease-of-Use (PEOU) (Davis et al., 1989). Perceived Usefulness (PU) means the degree of belief that users have in the potential of technology to develop and improve their ability to perform their business (Ros et al., 2014).

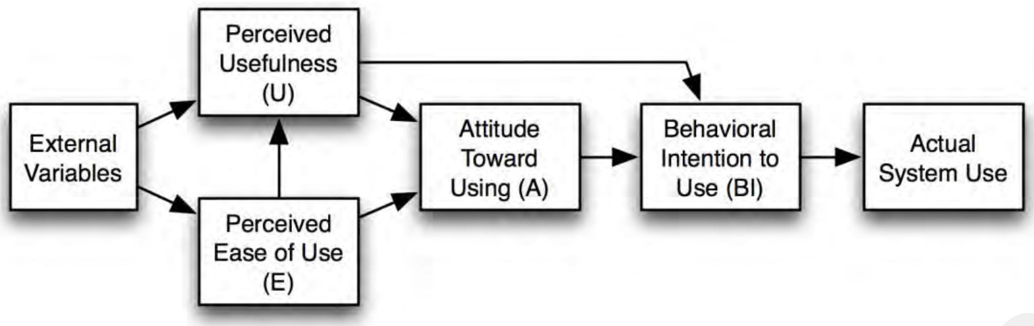

Figure 2.2 TAM Model by Davis 1986

Perceived Ease-of-Use (PEOU) means users' expectations about the efforts exerted when using the technology around which the study is based (Davis et al., 1989). Furthermore, TAM's theory examines the behavioural intention of individuals towards adopting a new type of technology which can be obtained by examining individuals' attitudes towards this technology (Kulviwat et al., 2007). This model has been used in many studies around the world concerning the extent to which individuals are receptive to technology (Ros et al., 2014). This theory may be good at understanding the constructs affecting individuals when the use of technology is mandatory for them, but may not be sufficient if users have the option of accepting or rejecting the adoption of the studied technology based on their personal factors (Kulviwat et al., 2007). TAM is somewhat old in the 1980s and the factors used in it were few and did not take into account certain effects that need to be studied, especially with the tremendous development of this era. This model has featured several extensions such as TAM2 and TAM3 by adding some factors of how much it has been used in many areas. It should be noted that UTAUT's development was based on previous studies, including TAM theory (Alharbi, 2014). Technology Acceptance Model remains one of the considered theories in the technology acceptance study.

2.4.3 Other Models

Aside from the TAM and UTAUT models, other models such as Computer Self-efficacy, Theory of Reasoned Action (TRA), Theory of Planned Behaviour (TPB). and Innovation Diffusion Theory (IDT) has been developed in the use of technology. Computer Self-efficacy Model was developed by Compeau and Higgins (1995) as shown in Figure 2.3.

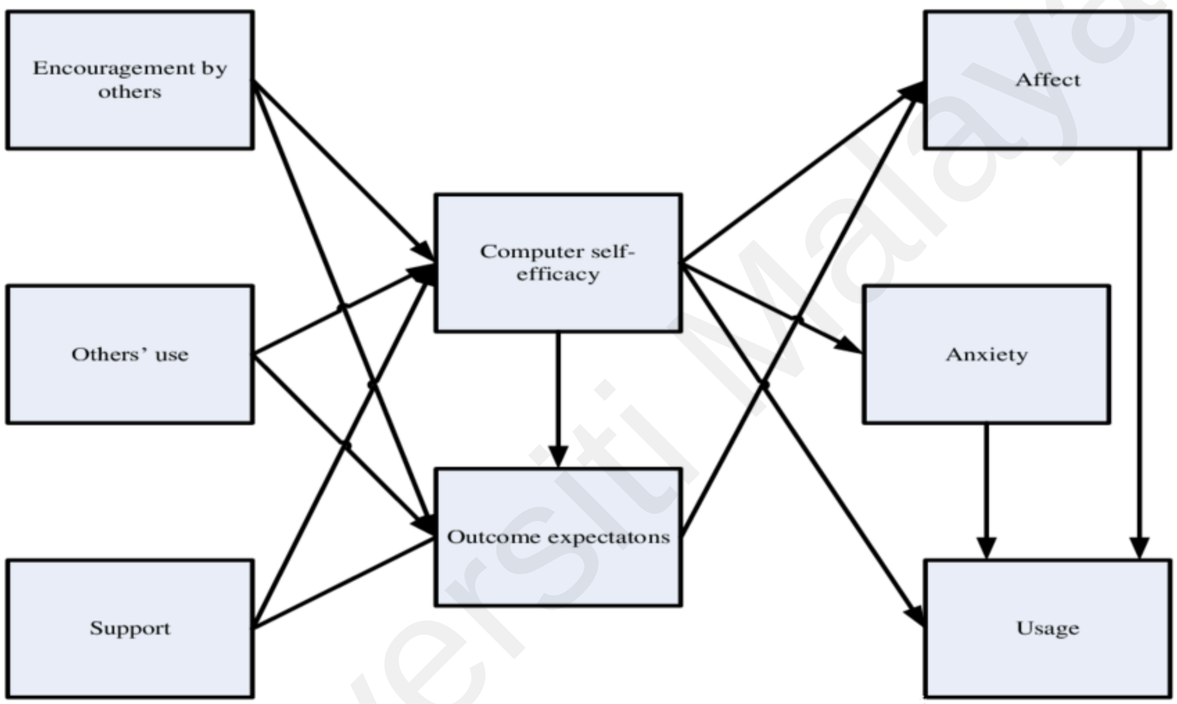

Figure 2.3 Computer Self-efficacy Model by Compeau and Higgins (1995)

Some of these theories were mainly a base for other theories as well and contributed to their development. Among the theories used in the field of technology is Theory of Reasoned Action (TRA), Theory of Planned Behaviour (TPB). and Innovation Diffusion Theory (IDT) (Brown et al., 2014). The TRA model is a theory of the psychosocial aspect that revolves around factors related to intentional behaviours and relationships between beliefs, attitudes, norms and behavioural intentions (Masrom & Hussein, 2008). TRA is one of the main pillars and an important model in theories concerning the study of human behaviours (Venkatesh et al., 2003). Although the theory of reasoned action is used in many areas, a number of models related to information systems management have been developed based on this theory (Masrom & Hussein, 2008).

On the other hand, the TPB is an extension of TRA theory by adding a perceived behavioural control (Venkatesh et al., 2003). This theory was developed by Ajzen in 1985 in order to predict behaviours in many research areas and the factor added to this theory indicates an individual's belief in how easy it is to implement behaviours (Masrom & Hussein, 2008). The third theory is IDT, a theory that has been employed and used since the 1960s to study the adoption of diverse innovations in various fields of agriculture and organisation (Masrom & Hussein, 2008). This theory consists of several factors: Relative Advantage, Ease of Use, Image, Visibility, Compatibility, Results Demonstrability, and Voluntariness of Use (Venkatesh et al., 2003). It is worth mentioning that many other theories have been developed in the field of information systems, either as based on theories or an extension of previously developed theories.

2.5 Factors Influencing the Use of Technology

The most frequently studied general constructs were social, educational, and behavioural. A few studies referred to technical factors as tangential topics rather than the focus. University students' intentions to use M-learning were affected by attitudes, subjective norms, and behavioural control (Cheon et al., 2012). The theory of planned behaviour offers a useful description of behaviour and intention (He & Jeng, 2016). A high percentage of intention to use M-learning in an American higher education context was measured by TPB and it was found that the most important concepts were attitudes, subjective norms, and behavioural control (Cheon et al., 2012). In the most frequently used constructs in the selected papers, it was clear that the Trust construct was most often used in the Commerce and Learning fields, whereas the Quality construct was most often used in M-learning, cloud computing, and educational technology.

Constructs of the TAM model were used in mobile learning, contrary to the UTAUT which was almost never used in this area. Facilitating Conditions were most often used in commerce, healthcare, and technology acceptance whereas they were almost never used to measure acceptance in mobile learning as shown in Figure 2.4. With the rapid improvements in technology, it is important to accommodate both student needs and organisational needs when implementing mobiles as learning tools (Lam et al., 2010).

Constructs / Domain	Attitude	SUBJECTIVE NORM	Personal Innovativeness	performance Expectancy	Effort Expectancy	Social Influence	Facilitating Conditions	Behavioral Intention	Perceived Usefulness	Perceived Ease of Use	Trust	Quality	*References*
M-learning								✓	✓	✓	✓	✓	Hamidi & Chavosh (2017)
Technology Acceptance	✓		✓	✓	✓	✓	✓	✓					Casey & Evered (2012)
Cloud Computing	✓	✓						✓	✓			✓	Shiau & Chau (2016)
Technology Commerce				✓	✓	✓	✓				✓		Baabdullah (2018)
Health Care				✓	✓	✓	✓						Hoque & Sorwar (2017)
Educational Technology									✓	✓		✓	Mohammadi (2015)

Figure 2.4 Constructs Frequency in Some Fields

Learning materials created for desktop or laptop use may not suit mobile devices unless altered to do so relating to screen size (Little, 2013). One issue which mostly affects mobile usage is everyday human behaviours, such as reducing internet bills, lending mobile phones to others without due care, and services that need payment (Lorenz & Kikkas, 2013). Few studies have compared learning processes that depend on computers and students' usage of mobiles (Martin &

Ertzberger, 2013). Students use modern mobile technologies in their daily lives that are expected to contribute to the way they gain knowledge (Carol Campbell, 2018).

It is recommended that studies are conducted to determine whether differences exist between users who can use mobiles and users who cannot via the TAM (Park et al., 2011). The UTAUT developer recommended that further studies examined extra constructs to ascertain how intention and behaviour can be predicted in addition to facts already established (Venkatesh et al., 2003).

2.5.1 Factors Influencing in General

It is clear that the Trust construct was most often used in the Commerce and Learning field, whereas the Quality construct was most often used in M-learning, cloud computing, and educational technology. Constructs of the TAM model were used in mobile learning, contrary to the UTAUT which was rarely used in this area. Facilitating Conditions were most often used in commerce, healthcare, and technology acceptance whereas they were rarely used to measure acceptance in mobile learning. Figure 2.4 shows the frequencies of constructs through different domains. Self-efficacy has an important effect on the benefits users expect from using computers and their feelings towards this. Moreover, results have shown that self-efficacy produces expectations that also have a favourable influence on others' attitudes (Compeau & Higgins, 1995). It has been confirmed that self-efficacy and outcome expectations influence users' effective and behavioural reactions towards IT (Compeau et al., 1999). Table 2.2 shows the frequency of constructs in the studies from the selected papers.

Table 2.2 Frequencies of Constructs

Constructs	Domain	Frequencies of Constructs in Some Selected papers
Attitude	cloud learning, M-learning, E-learning	13 Times
Subjective Norm	M-learning	4 Times
Personal Innovativeness	M-learning	4 Times
Performance Expectancy	M-learning, E-learning	14 Times
Effort Expectancy	M-learning, E-learning	13 Times
Social Influence	M-learning, E-learning	14 Times
Facilitating Conditions	M-learning, E-learning	14 Times
Behavioral Intention	M-learning, E-learning	22 Times
Perceived Usefulness	M-learning, E-learning	13 Times
Perceived Ease of Use	M-learning, E-learning	13 Times
Trust	M-learning, E-learning	4 Times
Quality	M-learning, E-learning	5 Times

2.5.2 Factors Influencing in Education

With the massive developments in the use of mobile phones and their applications in the field of educational processes, many studies have measured students' acceptance of M-learning and the associated factors. Most of these studies were based on models designed in the past to measure students' acceptance. The models were either generally added or modified from the existing models. The significant increase in the use of mobile phone devices has led to the need for a particular model to measure the extent to which students or learners accept this technology in the learning process. Moreover, it has been reported that there are limited studies focusing on the technical factors influencing learners' intention to use M-learning (Bidin & Ziden, 2013).

It is clear from the review that in terms of question one, many studies have investigated mobile technology. Almost one-third of these studies were on mobile learning. As for the most frequently used models, the answer to question two suggests that the UTAUT and TAM has been used in 62 and 28 articles, respectively. The remaining papers used other models. As for the last question of this study, it is clear that some technical problems need to be resolved in connection with the use of mobile devices as learning tools. Therefore, it is necessary to develop a model oriented to measure student acceptance of learning processes provided through the use of mobile phones from technical aspects. This would in turn lead to research by educational institutes or other organisations that wish to take advantage of the opportunity to use M-learning.

This study provided an overview of the inclusion of mobile technology in various fields, especially education. A systematic literature review has been conducted to answer four questions about mobile technology and acceptance models (Alghazi et al., 2020). This SLR included a review of papers published from 2011 to 2020. After scrutinising these papers, 127 related ones were selected and the rest excluded as they were not relevant. It is clear from reviewing the above studies that the majority revolved around the importance of M-learning and the factors that may affect the intention behind its use or implementation for education. Most studies concentrated on general factors while surveys were the most commonly used methodology for measuring acceptance.

Although research has stated that no studies have attempted to investigate technical factors, it has been mentioned in some articles. However, it is important to conduct more research to clarify this point to assist decision-makers who want to implement M-learning in education. This is of utmost importance in Arab countries where only a few studies have been executed. It is highly recommended to develop new models or extend existing ones to include technical factors, as almost no studies focused on this area. This study is significant for the education industry in illuminating whether these are important factors involving mobiles in the learning process. In addition, it gave a brief history of technology involvement in education. Some limitations could be discerned in this review. Firstly, the number of articles covered in this review was limited, so future studies may consider widening the search for better accuracy. Secondly, the smartphone industry is a rapidly developing sector, therefore, more studies need to be conducted in this field.

2.6 Previous Work

There are limited studies on the role or influence of technical factors on mobile education or the use of M-learning (Bidin and Ziden, 2013). Most of the reviewed studies extensively utilised different acceptance models, such as applying original models, whereas others used altered or modified models. One such study found that despite the enjoyment students might find in the relevance of the services provided through mobile education and also the importance of their acceptance of this type of education, this acceptance remains comparatively low in some Arab countries (Almaiah & Al Mulhem, 2019). One incentive to use mobile education is the ease of accessing the materials despite physical and time constraints, particularly if a high level of confidence exists among users that this type of education is compatible with students' devices (Almaiah et al., 2020).

Some researchers have planned the utilisation of the Mobile Learning Adoption Model (MLAM) and found that technological self-efficacy is a crucial element in encouraging students to accept M-learning (Almaiah et al., 2020). Furthermore, another study found that one key factor resulting in the success of mobile education among students is the corresponding support within universities for applying this type of education and taking advantage of its capabilities (Almaiah et al., 2016).

Though selection to find out whether victimisation of mobile devices is within the hands of scholars, a desire remains to research the factors affect student acceptance of mobile education (Almaiah et al., 2014). The acceptance of mobile education among students continues to be comparatively poor in some Arab countries (Almaiah et al., 2016). Therefore, considerable analysis is required to identify the factors behind and causes of these weaknesses. Researchers have developed a model that integrated the Technology Acceptance Model (TAM) with the updated DeLone and McLean's model (DL & ML). Findings found that among the factors connected to student intentions to explore such new technology is the quality of this type of M-learning (Almaiah & Alismaiel, 2019).

However, despite the emergence of e-learning, there are limited studies regarding the acceptance of mobile education among learners in Saudi Arabia (Almaiah & Alyoussef, 2019). A few researchers have reinstated the importance of e-learning in the region. For instance, Almaiah et al. (2019) stated recommended that once scholars gain greater assurance of the victimisation of this sort of technology, their enjoyment and use of it in educational life would increase. Some studies suggested that upon embarking on the inclusion of mobile education, it is necessary to address issues that may arise from the technical, educational and social aspects (Chavoshi and Hamidi, 2019). The importance of technology to modern life cannot be over-emphasised; however, it is equally pertinent to elucidate learners' knowledge and use of mobile education and according to Al-Shaya and Al-Eid (2018), these areas remain unnoticed and yet to be explored.

Improvements to M-technology extend the ways of learning far from the traditional classroom by providing opportunities to obtain knowledge more easily. Using mobiles for education can also be a key element of formal education (Cheon et al., 2012). Students have experienced difficulty in cooperating with each other in group activities when they depend on mobile computers (Chung et al., 2013). Tablets are not that difficult to use for entertainment, but this may not be replicated when they are used in education (Courtois et al., 2014). Nowadays, educators are surrounded by devices which they use for many purposes and which change the way the environment is managed and understood (Dai et al., 2012). Learning systems often fail to hold students' attention for the full duration of a class (Dai et al., 2012).

People intend to use applications depending on how far they enable better performance (Davis, 1989). M-learning offers a vital opportunity to learn as it is a method that may be fixed in the mind, particularly among youths who take a huge interest in mobile technology (Gedik et al., 2012). Students believe that mobile devices allow them to obtain knowledge faster, while allowing them to contact and help each other, and to learn through different methods (Gikas & Grant, 2013). The use of games consoles as M-learning tools will offer a more effective route if shared webspace can be found (Hemmi et al., 2014). It is important to illuminate the perceptions of learning languages using mobiles (Hsu et al., 2013).

To raise the effectiveness of M-learning, teachers should focus on the extent of students' desire for participation in this method of learning (Huang et al., 2012). Prior research provides positive feedback about implementing mobile technology in education to help students. As a result, usability should be further emphasised while developments are introduced for different devices in order to use programmes on different platforms (Ivanc et al., 2012). Student performance in the learning process can be raised by merging the system based on user preference and on learning which does not depend on the time or place due to the availability of mobile devices (Jeong & Hong, 2013). Recently, the way of teaching and learning is not necessarily confined to a traditional classroom. Therefore, mobile technology is needed to spread knowledge around the world at an affordable price (Keengwe & Bhargava, 2013).

Several factors have a considerable positive influence on student acceptance of learning via mobile devices. These are satisfaction, autonomy, system functions and interaction, and communication activities (Liaw et al., 2010). In reality, combining the real objects and M-technology offers a bright future for the education sector (Liu et al., 2013). Students can make the best use of their time to learn if they are equipped with M-learning materials with proven usefulness (Liu et al., 2010). It is possible for the same levels of students to learn any subject via mobiles in any part of the world (Looi et al., 2010). It is noticeable that university learners usually use their mobile devices for peer communication instead of learning. However, they encounter no problems in using mobiles as learning tools (Mahat et al., 2012).

Mobile devices can help parents to monitor how their children perform in a learning environment (Male & Pattinson, 2011). The use of technology may differ depending on the users' environment (Mori & Harada, 2010). The use of M-learning encourages students to learn alone without an instructor's help but meanwhile enhancing the interaction between them (Ng et al., 2013). Mobile technologies provide students with a learning environment without the need to face the teacher or be in the same place (Nguyen et al., 2014). Both learners and instructors intend to involve learning via mobiles and they have a positive attitude towards it. However, they do not have the same level of efficiency (Ozdamli & Uzunboylu, 2014). The student's role has been transformed from simply listening and passively receiving information into a knowledge seeker to whom the teacher only needs to provide instructions when necessary (Ramble & Bere, 2013).

Mobile devices or the internet can be a more effective way to coordinate both schools and parents (Rannu et al., 2010). One study of a group of participants showed that the use of laptops was preferred in the learning process (Sad & Göktas, 2013). Mobile technology offers huge support to develop education and help learners achieve success (Sheng et al., 2010). M-learning is not restricted to a specific area of learning, but rather provides learners with continuous help and cooperation from their colleagues (Shipee & Keengwee, 2014). People are encouraged to learn continuously through mobile devices unofficially instead of using computers officially (Sung & Mayer, 2013). Mobile devices which incorporate technology can be used inside or outside schools and institutes effectively, depending on how learners obtain the greatest benefit (Teri et al., 2014). Learning through mobile devices can improve education simply by connecting it to the internet (Terras & Ramsay, 2012).

A group of researchers have introduced an extension for TAM, named TAM2, by adding more constructs (Venkatesh & Davis, 2000). Technology has a more significant influence on modifying culture than real life and the influence of age (Viberg & Gronlung, 2013). Within one to two decades, learning through mobile devices and wireless technology will be integrated and make the world resemble a village covered and connected by mobile devices (Wentzel et al., 2005). Learners and teachers depend on internet-related tools which are believed to increase productivity (Zhao et al., 2009). Knowledge in the present time can be obtained from many resources rather than in traditional ways (Al Hamdani, 2013). The need remains for more nuanced definitions of mobile learning and how this relates to other definitions, such as ubiquitous learning (Elaish et al., 2019). Table 2.3 shows some of the recent studies in mobile learning.

Table 2.3 Recent Studies in M-learning

Studies	Model	Additive factors	Sample	Domain	Instrument
Darlan Sidik & Faisal Syafar 2020	UTAUT	External Influence, Quality of Services, Individual Innovativeness	students	M-learning	survey
Wan Wan Hamzah et al., 2020	UTAUT	none	students	M-learning	survey
Olumuyiwa et al., 2020	UTAUT	Mobile Devices Features , Course of Study , Attitude towards Use , Name of Institution	students	M-learning	questionnaires
Chao 2019	UTAUT	Perceived Enjoyment, Mobile Self-efficacy, Satisfaction, Trust, Perceived risk	students	M-learning	survey
Almaiah et al., 2019	UTAUT	Perceived Trust, Perceived Information Quality, Perceived Awareness, Availability of Resources, Perceived Compatibility, Self-Efficacy, and Perceived Security	students	M-learning	survey
Aliaño et al., 2019	UTAUT	Voluntariness to Use , Self-management of Learning , Perceived Gratification	students	M-learning	questionnaire

2.6.1 UTAUT vs TAM

TAM and UTAUT are models that have been used extensively in technology adoption and are the most cited theories in the field (Dajani & Yaseen, 2016). TAM theory is one of the theories that entered into the development of UTAUT theory which led to it being more general and comprehensive compared to other models in the study of individuals' adoption of technology. UTAUT theory offers a number of benefits to measure users' acceptance of a new type of technology, helping administrators understand the factors that lead to acceptance of technology. By studying several theories, researchers found that UTAUT's theory surpassed the theories compared to it, including TAM (Venkatesh et al., 2003). In addition, UTAUT is a rather modern theory compared to previous well-known theories in the field of technology acceptance and most used model in literature review as appeared in Figure 2.5. For these reasons, this theory has become the basis of the model developed in this study.

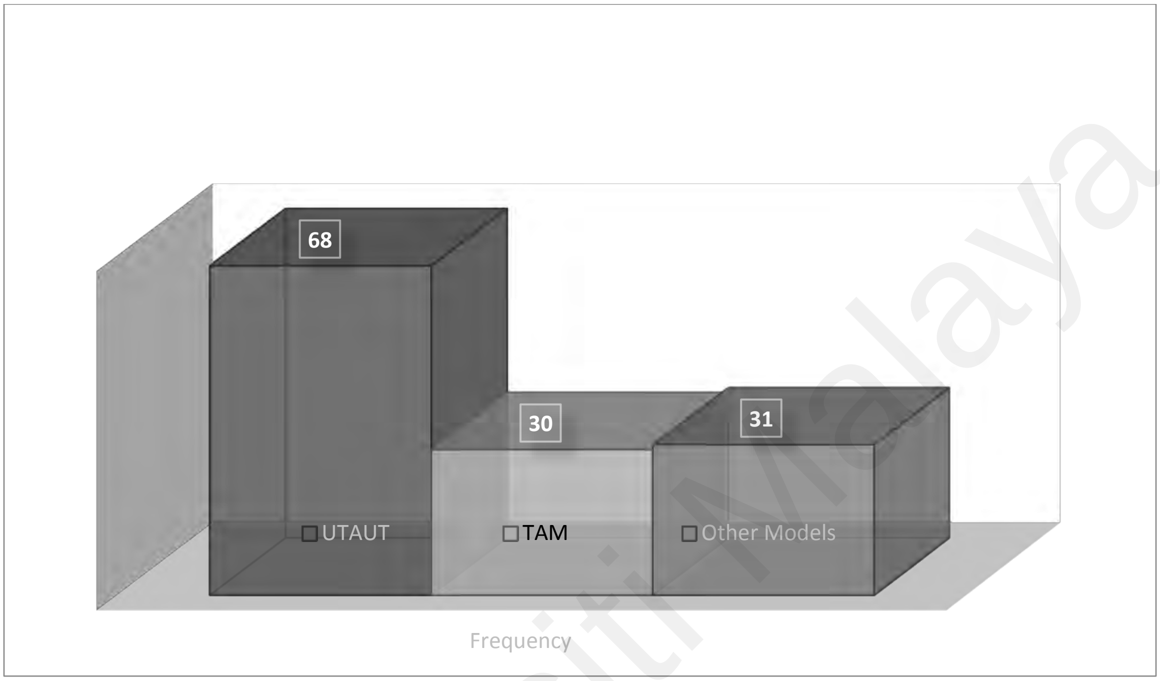

Figure 2.5 Frequencies of Acceptance Models

2.6.2 Technical Factors

While many factors have been investigated and considered in previous models, many technical factors were highlighted that could affect the acceptance of students to learn using mobile technology. Further to the factors associated with the human psyche, M-learning is still considered a help in the learning process, but not necessarily as the primary method of learning (Almaiah, 2018). Even though a large proportion of students believe that communicating with their teachers and colleagues is distinctly faster if it is conducted via smart devices (i.e., smartphones) (Adeboye, 2016), this leads to changing attitude of students toward M-learning (Ibrahim et al., 2017).

However, M-learning faces many challenges which are categorised into five types: technical, security, social, pedagogical, and challenges in the context of developing countries (Oyelere et al., 2016).

These challenges are due to different technical standards between countries (Wang & Higgins, 2005). Some of these challenges arise, for example, in African countries where the technology infrastructure is inadequate (Kaliisa & Picard, 2017). Although many studies have measured the technology acceptance of recipients, there remained deficiencies in those studies in the context of Arab countries, which is a limiting factor regarding cultural values and the extent of the impact technology acceptance in these countries (Wang & Higgins, 2005). Therefore, given these challenges and the limited investigations of the technical factors, there is a need to formulate the following hypotheses of the proposed model adopted from UTAUT. The UTAUT and TAM models are considered one of the most cited models in the area of using technology (El-Masri & Tarhini, 2017), but the UTAUT model was relied upon because it is the latest.

2.7 Research Gap

With the massive development in the use of the mobile phone and its applications in the field of educational processes, many of the studies have measured the acceptance of students toward M-learning and the factors that influence it. Many of the studies were based on models designed in the past to measure student acceptance (Dajani & Yaseen, 2016). These studies generally added or modified some factors in the studied models. The massive use of mobile phone devices led to the need for a particular model that measures to what extent students or learners accept this technology in the learning process. In order to apply M-learning successfully among students, technical factors must be supported (Sönmez et al., 2018). These factors include hardware performance and memory capacity, as well as other factors mentioned in his paper.

In a review conducted by the candidate over about 125 articles, most of the constructs did not mention technical factors specifically and almost all of them were general models. Although M-learning context field has increased in recent years, studies that focused on this area are still few based on a review done by the candidate. This has led the present researcher to do more investigations in this area to measure students' acceptance of this technology. Although research has stated that nearly no studies discussed technical factors, some papers did discuss these matters. However, it is important to perform more research to clarify this point to help decision makers who want to implement M-learning in education, especially in Arab countries where just a few studies have been conducted.

There many studies showed the importance of some technical factors. The different types of devices and the variety of operating systems used led to the existence of weaknesses in the performance of the device (Leydon & Schwartz, 2020). There was still a power disparity between the performance of a mobile device and other devices, such as desktops (Temesgene et al., 2019). One of the challenges facing M-learning is memory. If there is little memory, this leads to a lack of benefit from M-learning (Coşkun & Tanrikulu, 2019).

It is highly recommended to conduct new models or extend existing models to include technical factors, as almost no studies concentrated on this area. This study is significant for the education industry in illuminating whether these are important factors of involving mobiles in the learning process. In addition, it gives a brief history on the involvement of technology in education.

2.8 Chapter Summary

This chapter reviews previous studies in the field of education and developments, i.e., since its transition from traditional education in schools to education that can be obtained at any time and place. This chapter discusses e-learning, which was previously contributed through the emergence of mobile learning, and then goes on to shed light on M-learning and its importance, and highlights the challenges and difficulties facing this type of education by looking at previous studies in this field. In addition, this chapter examines the theories of technology acceptance and the measurement of factors influencing its adoption by scrutinising factors affecting human behaviours. Technical factors have had a share of the study in this chapter, which is clear from what was studied that there is still a lack of understanding of the extent to which they affect students' intention to use mobile smart devices in the educational process.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter, scientific methods were applied and used to ascertain the effectiveness and validity of the proposed models and hypotheses studied. After reviewing previous studies, the proposed model, which contained technical factors, was developed along with some of the original factors of the UTAUT model and its impact on the intention of students studying at the university to use mobile learning. UTAUT theory is one of the appropriate theories to be adopted in the study of M-learning acceptance (Mojarro et al., 2019). Additionally, UTAUT is an important theory for exploring students' intention to embrace learning through mobile devices (Fazamin et al., 2020). A group of researchers suggested using UTAUT to explore learning through electronic devices (Kayali & Alaaraj, 2020) and it is the best model that effectively measures technology acceptance (Chao, 2019).

Although the unified theory has been cited in many studies, there is still a limited use of this theory to study acceptance, especially in some aspects employing new methods of education other than traditional education (Wan et al., 2020). In this chapter, the development of the questionnaire used in this study was presented and the respective sections, including descriptive data (i.e., age, level, place of study, specialisation) and other aspects designed to evaluate students' intention towards M-learning acceptance. In addition, Structural Equation Modelling (SEM) data analysis method was used to examine the validity and effectiveness of the hypothesis developed in the introductory chapter of this thesis. Several scientific tools were used and explained in this chapter as well.

3.2 Research Design

The present study aimed to extend the UTAUT model in measuring student acceptance towards using mobile phones as a learning tool. This model incorporated the technical factors that might affect the users' intention to use such technology. A questionnaire containing 58 questions was developed to confirm the validity of the proposed model. Numerous tests and assessments were performed to confirm the validity of the instrument. Initially, a survey was designed based on several previous studies in M-learning and the inclusion of technology in public life. Thereafter, the questionnaire was sent to a number of experts worldwide for evaluation and Content Validity Index (CVI) tests. The next step was to translate the survey into Arabic so that students in the research sample could understand it using back translation method. A pilot study was conducted and the questionnaire was confirmed and cleared with the necessary modifications. The distribution of the questionnaire to the main sample was carried out using electronic questionnaires while taking necessary precautions to ensure data accuracy and prevent data duplication. SEM was used to test the hypotheses by using SmartPLS to confirm the results and validity of the proposed model.

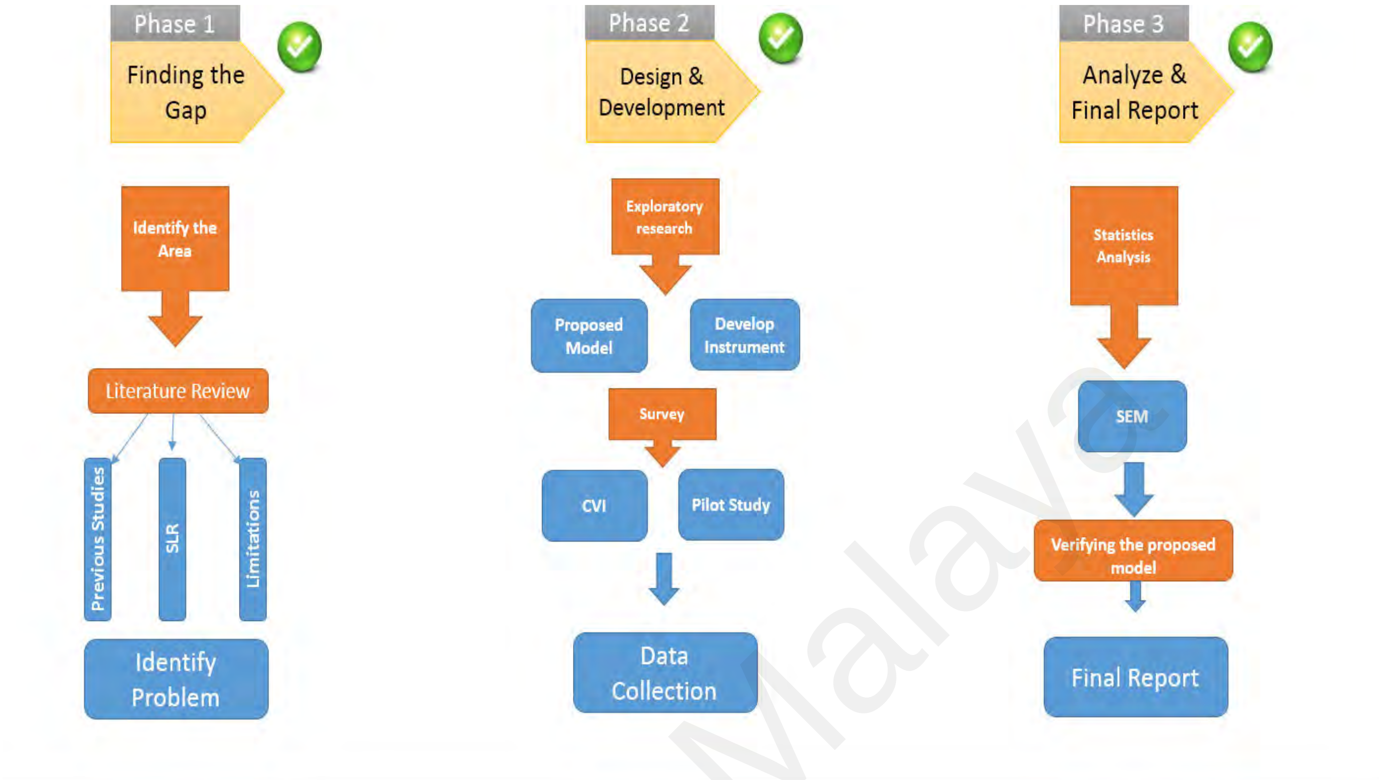

Figure 3.1 Research Flow

3.3 Development of the Proposed Model

Upon studying several previous models in the field of mobile learning, it was found that there is a need to focus on technical factors as important constructs for successful implementation of M-learning. Although M-learning has been implemented in several fields and places, the application of this new type of education in developing countries is still ineffective in achieving the desired outcomes. This is particularly the case in Arab Gulf countries, where M-learning is still considered a luxury education rather than a necessity. This belief is accompanied by the extent to which technology infrastructure affects students' responses and their intentions to use mobile learning.

This model was developed as an extension of the UTAUT model by incorporating technical factors to assess how it affects students' intentions to use mobile learning. The selection of UTAUT model was based on a review of several studies, which indicated that the model resolved the issues raised in previous models.

3.3.1 Hypothesis

From the literature review, as discussed in the previous section, there is a need to define the terms present in the hypotheses to be tested in this study. Therefore, for each hypothesis, the important terms were defined based on the various descriptions and recommendations from previous literature as presented below;

H1: Performance Expectancy has a significant influence on the intention to use M-learning among students at the University of Hail.

Performance Expectancy was defined as " the extent to which people are confident that using a given system will help them finding support in their performance" (Fazamin et al., 2020). This definition was adopted in this study and performance expectancy was defined as the degree at which a student increases the knowledge gained by using M-learning.

H2: Effort Expectancy has a significant influence on the intention to use M-learning among students at the University of Hail.

According to the original UTAUT model, effort expectancy is defined as "the simple level associated with the use of a system" (Fazamin et al., 2020). In this study, the factor was defined as the degree of ease associated with the use of mobile technology in the learning process.

H3: Social Influence has a significant influence on the intention to use M-learning among students at the University of Hail.

Masrom and Hussein (2008) defined social influence as "the degree to which an individual perceives that others believe he or she should use the new system" (Masrom & Hussein, 2008). In line with this definition, the factor was redefined as the degree to which a student believed that the important surrounding community encouraged the use of M-learning.

H4: Price Value has a significant influence on the intention to use M-learning among students at the University of Hail.

Price has various meanings and uses in different aspects. Price value is the perceived benefit of using technologies compared to the associated cost (Kumar & Bervell, 2019). Another definition for price value is the students' belief that the benefit of using smart learning via mobile devices was better compared to the cost of the devices and services (Alghamdi, 2017). In the Unified Theory, price value focused on the financial charge associated with buying devices and services (Issaramanoros et al., 2018). The higher the price for smart devices used in mobile learning, the lower the intention to use this type of education (Fox-Turnbull, 2018). Price value was found to have a positive influence on students' intent to embrace M-learning (Alghamdi, 2017). Therefore, it was defined as the student's belief that the value of mobile technology was reasonable for it to be used as a learning tool.

H5: Device Connectivity has a significant influence on the intention to use M-learning among students at the University of Hail.

Connectivity is a term used to describe " how well hardware or software devices can communicate with a range of other devices" (Computer Hope, 2017). Connectivity was defined in this study as the ability to learn through mobile technology by communicating with several devices in different places.

H6: Device Compatibility has a significant influence on the intention to use M-learning among students at the University of Hail

According to some researchers "compatibility standards assure the user that a component or sub-system can successfully be incorporated and be 'inter-operable' with other constituents of a more extensive system of closely specified inputs and outputs" (David & Steinmueller, 1994). Under the proposed model, it was defined as the ability of the user to apply mobile device to in learning through several platforms or programmes, regardless of the sources.

H7: Device Security and Reliability have a significant influence on the Intention to use M-learning among students at the University of Hail.

Mobile device security was defined as "the measures taken to protect sensitive data stored on portable devices" (Lerner, 2019). In this study, in this study, it was defined as the student's belief that data used for M-learning are protected and highly reliable.

H8: Device Processing Power has a significant influence on the intention to use M-learning among students at the University of Hail.

A processor can be described as "an electronic device that performs calculations" (Mugivane, 2014). In the proposed model, a mobile processor could accomplish calculation tasks and facilitate easy and flexible learning via mobile technology.

H9: Device Memory capacities has a significant influence on the intention to use M-learning among students at the University of Hail.

Computer memory is "any physical device capable of storing information temporarily, like RAM (random access memory), or permanently, like ROM (read-only memory). Memory devices utilise integrated circuits and are used by operating systems, software, and hardware" (Computer Hope, 2017). In this study, device memory was redefined as the ability of mobile technology to absorb, store, and transfer educational media of various sizes.

H10: Device Performance has a significant influence on the intention to use M-learning among students at the University of Hail.

Performance is described as "the accomplishment of a given task measured against presently known standards of accuracy, completeness, cost, and speed" (Business Dictionary, 2020). By using mobile technology in education, device performance was defined as the accomplishment of learning tasks through mobile devices in a specified period and time according to known standards.

H11: Network Coverage has a significant influence on the intention to use M-learning among students at the University of Hail

The internet has been defined previously as "a global network of networks used to exchange information using the TCP/IP protocol. It allows the usage of electronic mail and accessing and retrieval of information from remote sources" (Mugivane, 2014). Here, it was rephrased as network coverage and redefined as the ability to use mobile devices to access network from several places for learning purposes.

H12: Network Speed has a significant influence on the intention to use M-learning among students at the University of Hail.

Network speed has been raised in numerous forums over the past few decades and had become a factor that drive competitions among communication companies. In the present study, it was defined as the speed of communication via a mobile device (i.e., smartphone) and the duration spent to complete the learning process that involves browsing, downloading, and sending educational materials.

These factors were selected according to their importance in affecting M-learning as reported in several studies. The different types of devices and the variety of operating systems used led to the existence of weaknesses in the performance of the device (Leydon & Schwartz, 2020). Temesgene et al. (2019) reported a power disparity exists between the performance of a mobile device and other devices, such as desktops. Besides, one of the challenges of M-learning is device memory as the insufficiency may limits its benefits in M-learning (Coşkun & Tanrikulu, 2019). Other problems that have been demonstrated to influence the success of M-learning include insecurity (Dolawattha et al., 2019), device compatibility (Almaiah et al., 2019), connectivity issues (AlHunaiyyan et al., 2017; Jinot, 2019; Willemse et al., 2019) and network speed (Coşkun & Tanrikulu, 2019).

The importance of network coverage in M-learning has been highlighted in a few studies. Coşkun and Tanrikulu (2019) concluded that one of the issues affecting learning through mobile devices is the network speed. In another study, good network coverage was reported as key in the successful application of M-learning application and enabling to benefit from the technology (Willemse et al., 2019). In addition, the massive advancement in the field of the internet has significantly improved the connectivity between different types of devices (AlHunaiyyan et al., 2017).

3.3.2 The Proposed Model

Based on the previous studies discussed, the proposed model of technical factors and UTAUT factors were designed to test the hypotheses developed in this study as shown in Figure 3.2.

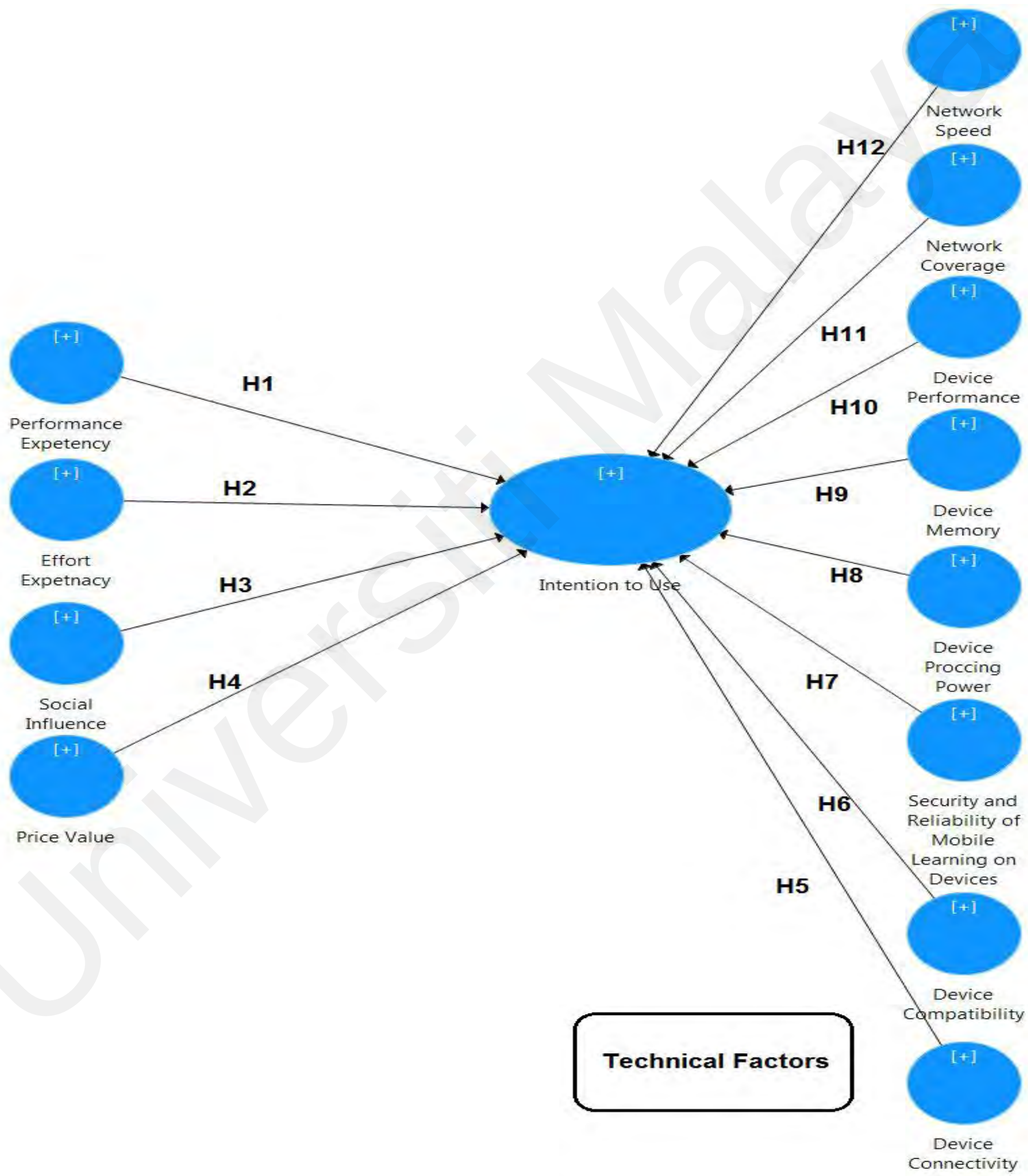

Figure 3.2 The Proposed Model

3.4 Research Instrument Development

In measuring the proposed model and hypotheses, a questionnaire was developed and adapted from several sources (Appendix A). As mentioned in a review, survey is the most used methodology to measure acceptance in the field of technology (Alghazi et al., 2020. The questionnaire was divided into two parts; measuring the original UTAUT factors and those related to technical factors. A 5-point Likert scale ranging from 1 = "strongly agree" to 5 = "strongly disagree", was used in presenting the items in questionnaire. This scale was selected based on its popularity as it is widely used by researchers and considered as one of the best scales in measuring responses (Abdel Fattah, 2008) as shown in Figure 3.3.

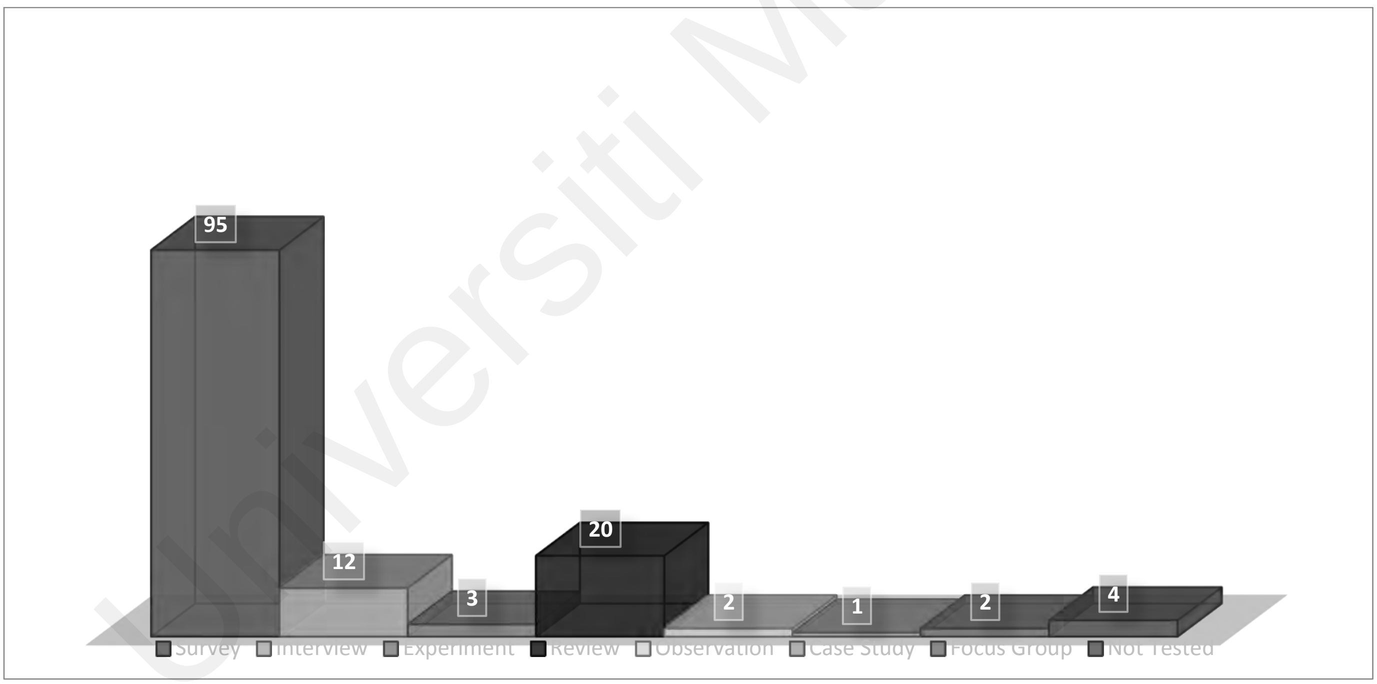

Figure 3.3 The Most Used Methodology

3.4.1 Developing the Survey

More items were adopted from the UTAUT model since it is the basis of the model developed in this study. Although there is limited research on technical factors, several items were adopted from various related studies (Appendix A). The sections and sub-sections of the questionnaire are presented as follows:

1. **Performance Expectancy**
   a. I find using mobile leaning apps useful in my daily life.
   b. Using mobile learning helps me accomplish things more quickly.
   c. Using mobile learning increases my knowledge.
   d. My productivity such as complete the assignments faster will increase if I use mobile learning.
   e. If I use mobile learning, I will get high marks in my course.
2. **Effort Expectancy**
   a. Learning how to use mobile devices in education process is easy for me.
   b. My interaction with mobile devices is clear and understandable.
   c. I find mobile learning easy to use.
   d. It is easy for me to become skilful when using mobile learning.
   e. My interaction with mobile learning will be clear and understandable.
3. **Social Influence**
   a. People who are important to me think that I should use mobile learning
   b. People who influence my behaviour think that I should use mobile learning.
   c. People whose opinions that I value prefer that I use mobile learning.
   d. I think my teachers will be helpful in the use of mobile learning.

e. In general, my university will support the use of mobile.

4. **Device Performance**

    a. If I learn through my mobile device, I will increase my chances of getting more knowledge.

    b. Using my mobile device to learn improves my performance in my courses.

    c. Using my mobile device to learn improves my productivity in my courses.

    d. Using my mobile device to learn improves my effectiveness in my courses.

5. **Device Compatibility**

    a. Learning through mobile is a good thing if it can be used within multi-platform (Android, iOS ... etc.).

    b. I will involve in online education if it can be used through my mobile.

    c. I will use media files of my course if my mobile can play them.

    d. I think my smart phone can fit with online course materials.

    e. If my mobile run lectures and learning materials smoothly I will continue to learn.

6. **Device Connectivity**

    a. I will spend more time on mobile learning if I could access it anywhere, anytime.

    b. Mobile learning would be useful if my device supports high speed connectivity.

    c. I have no problem to connect to different generations of speed (3G, 4G... etc.) from my device to interact with online courses.

    d. My phone has different ways to connect with others devices, such as Wi-Fi and Bluetooth to share knowledge.

    e. It would be useful to have a phone that got variety of connectivity types to exchange course files with my classmates.

7. **Security and Reliability of Mobile Learning on Devices**
   a. If mobile learning protects the security and privacy of students, I would use it.
   b. Mobile learning provides features that can prevent unauthorised people to access private data.
   c. I believe it is safe to use my mobile to learn.
   d. I think learning through my mobile will provide reliable information.
8. **Device Processing Power**
   a. I have a powerful device to start using mobile learning.
   b. I will accomplish more learning tasks through my mobile if it is quicker than using classic way.
   c. Nowadays, smart phones are strong enough to handle mobile learning.
   d. I believe my smart device offers the service that is superior in every way.
   e. I would use my phone to learn if it got high ability to deal with data.
9. **Device Memory Capacities**
   a. I will download learning materials (lectures, slides ...etc.) if I have enough space in my mobile.
   b. Learning through mobile would be more sufficient if it comes with a large memory card.
   c. I have no problems with downloading big size files of my course into my phone.
   d. It is useful to have a large memory capacity to store learning materials.
   e. I would download more educational contents If I am able to increase my phone memory capacity.

10. **Network Coverage**

a. My usage of mobile learning will increase with good network coverage.

b. My university provides a good internet network access.

c. Internet network coverage in public helps me to use my phone to learn.

d. Getting access to the internet everywhere would increase my time on the mobile learning apps.

11. **Network Speed**

a. Mobile learning will enhance my knowledge as I get information quickly.

b. I intend to use mobile learning if my university provides fast internet.

c. Using my phone is relatively faster to learn than using public network.

d. My university provides a fast access to the internet.

e. I would download more course materials on my phone if there is a fast coverage.

12. **Price Value**

a. Mobile devices with good specifications for the purposes of learning are reasonably priced.

b. Mobile learning is a good value for the money.

c. Using my mobile devices to learn is reasonably priced comparing with other learning channels like PC.

13. **Intention to use M-learning**

a. I intend to use mobile learning in the next months.

b. I predict I would use mobile learning in the next months.

c. I plan to use mobile learning in the next months.

3.4.2 Instrument Experts' Validation

It is recommended that a content validity index (CVI) is conducted to confirm the suitability of the indicators designed as associated factors in a research (Hair et al., 2017). Therefore, the questionnaire developed in this study was distributed worldwide to five experts in the research area and the instrument was updated based on their comments and feedback (Appendix B). The experts were from various specialities; two were from information systems (i.e., including technology adoption), one each from mobile learning, computer human interaction and multimedia security. Content validity and face validity are commonly and mutually used in research, although they differ to certain extent (David et al., 2004). Content validity is generally defined as the degree to which a number of associated elements can represent the factors being studied (Polit & Beck, 2006).

In order to determine the extent of the relationship between the items and the constructs on which the research was conducted, the content validity was applied in two steps. The first was to develop these items and send them to a number of arbitrators to give their opinions on the validity, as well as the strength and clarity of their relationship with constructs (Zamanzadeh et al., 2015). Researchers often use the CVI to test the content validity by allocating relevant scores ranging from 1 to 4 and link them with the number of experts who will evaluate these elements. The acceptable criterion for content validity is between 1 and 0.71 for CVI (Natalio et al., 2014). In addition, Kappa Coefficient is used to evaluate expert responses (Zamanzadeh et al., 2015), and values between 1 and 0.60 are considered acceptable (McHugh, 2012).

Based on responses from the five experts' evaluation, three items were excluded for poor evaluation and four other elements were corrected as their results were close to the acceptable level. The following Table 1 reflects the CVI results.

Table 3.1 Content Validity Index (CVI) Results

		Relevance			Clarity						Relevance			Clarity			
ITEMS	TOTAL	No. Expert	CVI	kappa	No. Expert	CVI	kappa	Statues	ITEMS	TOTAL	No. Expert	CVI	kappa	No. Expert	CVI	kappa	Statues
1	3	5	0.600	0.418	5	1	1	Corrected	32	3	5	0.600	0.418	5	1.000	1.000	Excluded
2	5	5	1.000	1.000	5	1.000	1.000	Validated	33	5	5	1.000	1.000	5	1.000	1.000	Validated
3	4	5	0.800	0.763	5	1.000	1.000	Validated	34	5	5	1.000	1.000	5	1.000	1.000	Validated
4	4	5	0.800	0.763	5	0.600	0.418	Corrected	35	4	5	0.800	0.763	5	0.800	0.763	Validated
5	4	5	0.800	0.763	5	1.000	1.000	Validated	36	5	5	1.000	1.000	5	1.000	1.000	Validated
6	5	5	1.000	1.000	5	1.000	1.000	Validated	37	4	5	0.800	0.763	5	1.000	1.000	Validated
7	5	5	1.000	1.000	5	1.000	1.000	Validated	38	5	5	1.000	1.000	5	0.800	0.763	Validated
8	5	5	1.000	1.000	5	1.000	1.000	Validated	39	5	5	1.000	1.000	5	0.800	0.763	Validated
9	5	5	1.000	1.000	5	1.000	1.000	Validated	40	5	5	1.000	1.000	5	0.800	0.763	Validated
10	5	5	1.000	1.000	5	0.800	0.763	Validated	41	5	5	1.000	1.000	5	1.000	1.000	Validated
11	4	5	0.800	0.763	5	0.800	0.763	Validated	42	5	5	1.000	1.000	5	1.000	1.000	Validated
12	4	5	0.800	0.763	5	0.800	0.763	Validated	43	5	5	1.000	1.000	5	1.000	1.000	Validated
13	5	5	1.000	1.000	5	0.800	0.763	Validated	44	5	5	1.000	1.000	5	1.000	1.000	Validated
14	5	5	1.000	1.000	5	1.000	1.000	Validated	45	5	5	1.000	1.000	5	1.000	1.000	Validated
15	4	5	0.800	0.763	5	1.000	1.000	Validated	46	5	5	1.000	1.000	5	0.800	0.763	Validated
16	3	5	0.600	0.418	5	0.800	0.763	Excluded	47	5	5	1.000	1.000	5	1.000	1.000	Validated
17	4	5	0.800	0.763	5	0.800	0.763	Validated	48	5	5	1.000	1.000	5	1.000	1.000	Validated
18	4	5	0.800	0.763	5	1.000	1.000	Validated	49	5	5	1.000	1.000	5	0.600	0.418	Corrected
19	4	5	0.800	0.763	5	0.800	0.763	Validated	50	4	5	0.800	0.763	5	1.000	1.000	Validated
20	4	5	0.800	0.763	4	1.000	1.000	Validated	51	5	5	1.000	1.000	5	1.000	1.000	Validated
21	5	5	1.000	1.000	5	0.600	0.418	Corrected	52	5	5	1.000	1.000	5	1.000	1.000	Validated
22	5	5	1.000	1.000	5	1.000	1.000	Validated	53	5	5	1.000	1.000	5	1.000	1.000	Validated
23	5	5	1.000	1.000	5	1.000	1.000	Validated	54	5	5	1.000	1.000	5	1.000	1.000	Validated
24	5	5	1.000	1.000	5	1.000	1.000	Validated	55	5	5	1.000	1.000	5	1.000	1.000	Validated
25	5	5	1.000	1.000	5	0.800	0.763	Validated	56	4	5	0.800	0.763	5	0.800	0.763	Validated
26	5	5	1.000	1.000	5	1.000	1.000	Validated	57	5	5	1.000	1.000	5	0.800	0.763	Validated
27	5	5	1.000	1.000	5	1.000	1.000	Validated	58	4	5	0.800	0.763	5	0.600	0.418	Excluded
28	5	5	1.000	1.000	5	0.800	0.763	Validated	59	4	5	0.800	0.763	5	0.800	0.763	Validated
29	4	5	0.800	0.763	5	0.800	0.763	Validated	60	4	5	0.800	0.763	5	0.800	0.763	Validated
30	5	5	1.000	1.000	5	1.000	1.000	Validated	61	4	5	0.800	0.763	5	0.800	0.763	Validated
31	5	5	1.000	1.000	5	1.000	1.000	Validated									

3.4.3 Back Translation

The questionnaire was translated into Arabic by an accredited office employing the back-translation method, which enhances the goodness of documentation (Son, 2018). Thereafter, a language specialist translated the instrument back to English, which is the original language and this procedure was undertaken to assure accuracy. Moreover, back-translation was conducted because Arabic is the mother tongue of the students at Hail University. Multiple steps were implemented in this process to ensure the validity of the questionnaire. First, after the questionnaire was built in English, it was sent to a number of experts for language clarity assessment. Second, the questionnaire was sent to an accredited language translation office to be translated into Arabic as shown in Figure 3.4. Third, a specialist from the English department at Hail University was contacted to reconfirm the translation and match it with the English version (Appendix C). After the accreditation from all of these entities, the questionnaire was published electronically and distributed to students for data collection.

Aledresi
Authorized Translation Office
License No. (720)
Memb. No. (202001171041)

الإدريسي
للترجمة المعتمدة
ترخيص رقم (٧٢٠) فرع مكة
عضوية رقم (٢٠٢٠٠١١٧١٠٤١)

الاسم:
المرحلة العمرية:
محل الإقامة: مدينة حائل أو المناطق الريفية
مستوي الدراسة: الأول والثاني وحتى المستوي الثاني عشر
مكان الدراسة : المقر الرئيسي في مدينة حائل – فروع الجامعة في القرى التابعة لمنطقة حائل
التخصص الدراسي:
المستوي التعليمي: الدبلوم- البكالوريوس
مستوي الدخل: جيد جدا-جيد- مقبول – ضعيف
ملاحظة (المقصود بالهاتف النقال أو المحمول هو الأجهزة الذكية المتوافرة في الأسواق مثل الأيفون – سامسونج – هوواوي .... إلخ)

م	البند	أوافق بشدة	أوافق	محايد	لا أوافق	لاأوافق بشدة
١	أجد أن استخدام التطبيقات أو البرامج التعليمية من خلال الهاتف المحمول مفيدة في حياتي اليومية					
٢	يساعدني التعلم عبر الهاتف المحمول على إنجاز الأشياء بسرعة أكبر					
٣	يزيد التعلم عبر الهاتف المحمول من اكتسابي للمعرفة					
٤	اذا استخدمتُ التعلم عبر الهاتف المحمول ستزداد إنتاجيتي وذلك مثل إنجاز الواجبات والدروس بشكل أسرع					
٥	اذا استخدمتُ التعلم عبر الهاتف المحمول فسأحصل علي درجات عالية في المواد والبرامج الدراسية					
٦	تعلم كيفية استخدام الأجهزة المحمولة في العملية التعليمية أمر سهل بالنسبة لي					
٧	تفاعلي مع الأجهزة المحمولة أمر واضح ومفهوم					
٨	استخدام التعلم عبر الهاتف المحمول أمر سهل بالنسبة لي					
٩	من السهل بالنسبة لي أن أصبح ماهراً في استخدام التعلم عبر الهاتف المحمول					
١٠	تفاعلي مع التعلم عبر الهاتف المحمول سيكون واضحا ومفهوما					
١١	يعتقد الأشخاص المهمين في حياتي أنه ينبغي علي استخدام التعلم عبر أجهزة الهاتف المحمول					
١٢	يعتقد الأشخاص الذين يؤثرون في سلوكي أنه ينبغي علي استخدام التعلم عبر أجهزة الهاتف المحمول					

https://twitter.com/edrisitarjama
https://facebook.com/edrisitarjama1
https://linkedin.com/company/edrisitarjama
https://www.youtube.com/channel
Next TO Umm Al-Qura Uni., Azziah Dist., Makkah Mob. 00966569126116- email: info@edrisitarjama.com

Figure 3.4 Sample of Certified Translation

3.4.4 Instrument Face Validity

Face Validity is an assisted and complementary evaluation of content validity, which facilitates the definition of the instrument's validity to be used by individuals or distributed to a given sample of respondents (Zamanzadeh et al., 2015). Although face validity and content validity have been used in several studies, both methods were employed in this study to ensure higher reliability and validity of the questionnaire. The questionnaire was distributed to a number of students at Hail University with the existing supervisors performing the face validity.

Generally, in new or modified models, the researcher should undertake a face validity test (David et al., 2004) as applied in this study. This was performed by distributing the questionnaires to a representative sample (i.e., in this case a group of students) and the results confirmed the validity of the questionnaire.

3.4.5 Study Population and Sample Size

This study was applied to students at Hail University in Saudi Arabia. The sample was taken from all the disciplines available at the university for a variety of sources of responses from the students. The target group was university students of all levels and ages; hence, participants were selected from the preparatory year to higher study levels. Numerous ways have been reported in various studies on how to calculate the required sample size. This includes the use of software such as Sample Size Calculator (Alalawi et al., 2014) and the widely applied KREJCIE and MORGAN table (1970) (Chuan, 2006). This method calculates the required sample as represented in the following equation (Krejcie & Morgan, 1970):

$$S = X^2 NP(1-P) \div d^2(N-1) + X^2P(1-P).$$

As S is the required sample size, X^2 represents the value of the chi-square, N population (students in total in the university), P population percentage and d for the extent of accuracy expressed as a ratio.

Table 3. 2 Krejcie and Morgan Table (Krejcie & Morgan, 1970)

Table for Determining Sample Size from a Given Population

N	*S*	*N*	*S*	*N*	*S*
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note.—*N* is population size.
S is sample size.

The number of students at Hail University in almost all disciplines was 32,292 according to the statistics conducted by the university (University of Hail, 2020). Therefore, according to the

Krejcie and Morgan table, the minimum required sample was 380 students. To ensure accuracy, a computational programme, G*Power was applied to ascertain the number of students required for the study. The results showed that the minimum sample size is 110 as shown in Figure 3.5. The number of respondents enrolled in this study was 612, which was well above the minimum requirement to yield better and reliable results.

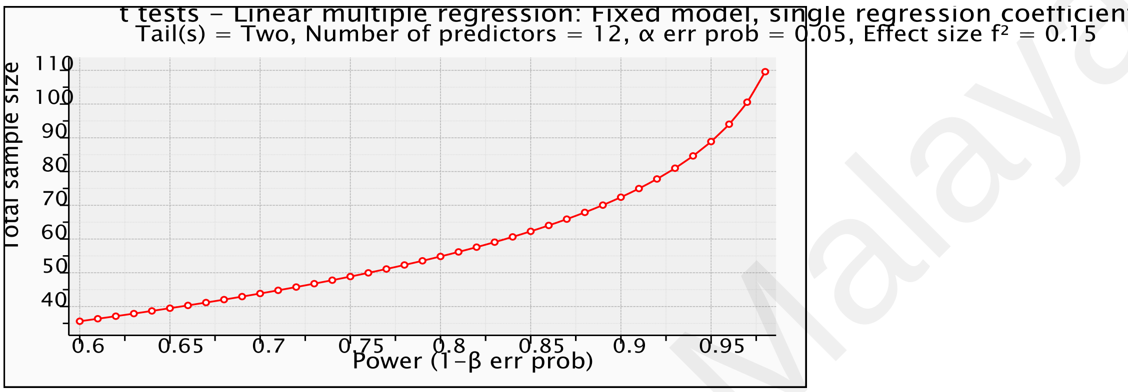

Figure 3.5 G*Power Test

3.5 The Pilot Study

A pilot study is a test performed on a small sample related to the main study population to test the instrument or interviews to be conducted (Teijlingen & Hundley, 2001). Pilot test is usually undertaken before proceeding to the larger sample or the primary respondents to be studied. Browne (2010) suggested the appropriate number of small sample size for pilot study to be at least 30 subjects in order to evaluate the questionnaires (Whitehead et al., 2016). In this study, the preliminary study was conducted on a sample of 72 students from different disciplines at Hail University. The results of the tests revealed good overall resolution performance with a number of items that were excluded for their weakness and inappropriateness to represent factors in the proposed model. Excluded items were three elements each in Network Speed and Device Compatibility, two each in Effort Expectancy, Social Influence, Device Connectivity, Device Memory Capacities, and Device Memory, and one in Device Performance and Device Processing Power. Although the minimum number of items for constructs representation could be one element per construct to be sufficient (Jeff, 2018), the number of items remaining after the pilot study in most factors was three or more.

3.6 Data Collection Procedure

The primary sample in this study was undergraduate and postgraduate students attending the University of Hail in the Kingdom of Saudi Arabia. The questionnaires were distributed electronically through the Information Technology Department at the University of Hail in order to reach the largest number of students. This provided the researcher an opportunity to distribute the electronic questionnaires to recipients and registered their interest to participate in the study via e-mails to avoid repeated responses from the same person. A total of 612 responses were received from the recipients representing students enrolled at the university, from several professional and academic specialisations, for each gender and from different backgrounds.

3.7 Data Analysis Method

Over the years, researchers have used many scientific tools to test their hypotheses and suggested models. This study included most of these tools to ascertain the effectiveness and validity of the proposed model and the extent to which technical factors influence the intention of university students to use mobile learning. The first section is descriptive data that was obtained from the completed online questionnaire and extracted using Microsoft Excel, 2013 (Appendix D). in the second section, data analyses were conducted using SEM by examining the validity and reliability involving a number of tests.

3.7.1 Descriptive Analysis

In quantitative studies, descriptive data are used to summarise the sample or study population and infer important information, which are considered as the basis of quantitative analysis (Trochim, 2020). This study applied several metadata to obtain information about the studied population and to ascertain the alignment of data and the study objectives. The descriptive data in this study included the gender, age, study levels, residential area, location of respondents and income levels.

The area of residence was confined to the Hail area (where the university is located) or its villages, with another option for those who live outside the region. Study levels had a share in the metadata, starting from the preparatory year to the higher levels. Besides, the location of the study whether in the main university building or its branches were also considered. In addition, the colleges where the students were studying was shown through all the colleges at the university and the number of students participating in those colleges. Finally, the income level was presented in four options, ranging from poor (students who could hardly afford mobile devices) to very good (students who could easily afford mobile devices and good specification).

3.7.2 Structural Equation Modelling

Structural Equation Modelling (SEM) was used to test the hypotheses. This technique has been used by researchers and it helps to overcome the weaknesses of conventional methods in statistical analysis (Hair et al., 2017). The two types of SEM technique; Covariance-Based SEM (CB-SEM) and Partial Late Square (PLS-SEM), were used in this study. SEM was employed since it can easily handle both reflective and formative measurement models and it is applicable to constructs having one item (Hair et al., 2017). According to the approach proposed by Anderson et al. (1988), a two-step modelling approach was adopted in this study to evaluate the measurement model and the structural model, along with testing the theory (Anderson & Gerbing, 1988). In addition, the measurement model was analysed using validity and reliability tests before assessing the structural model.

3.7.3 Analysis of Measurement Model

The measurement model analysis was divided into two parts: Convergent Validity and Discriminant Validity (DV) tests. In the first section, three parts were tested: Average Variance Extracted (AVE), Composite Reliability (CR), and Cronbach's Alpha. The second section of the measurement model analysis was the DV test consisting of three phases: Fornell-Larcker Criterion, Cross-Loadings, and Heterotrait-Monotrait Ratio (HTMT). Furthermore, two steps were employed to assess the structural model of the proposed model, the Path Coefficient and R-Square. Both steps were tested to confirm the results of the proposed model.

3.7.3.1 Convergent Validity

Cronbach's Alpha provides a reliability evaluation based on the relationships that are exchanged between the index variables under study (Hair et al., 2017). This test has a value of between 0 and 1, and when the result is closer to 1, higher reliability is achieved. If the result is 0.9 or higher, the reliability is very high, whereas if the result is less than 0.5, the reliability is low (Perry et al., 2004). Additionally, it is preferable to perform more reliability tests due to some of the limitations associated with Cronbach's Alpha (Hair et al., 2017). This induces the need to use CR, which takes into account other considerations of the indicator variables and its results are limited to 0 and 1. Moreover, it is considered acceptable when the value is between 0.6 and 0.7 and satisfactory if it is between 0.7 and 0.9 (Hair et al., 2017). The third section of Convergent Validity is the AV which measures the level of variance that can be captured by factors towards the level due to the result of the measurement error. If the result is greater than 0.7, it is considered highly reliable while values between 0.5 to 0.7 are considered acceptable (Alarcón & Sánchez, 2015).

3.7.3.2 Discriminant Validity

Fornell-Larcker Criterion, Cross-Loadings, and Heterotrait-Monotrait Ratio (HTMT) tests can be used by researchers to confirm DV (Almaiah, & Al Mulhem, 2019). The first of these steps, Cross-Loadings, has been traditionally employed by researchers to ensure the validity of the indicators in a model (Hair et al., 2017). In this section, the cross-loadings of any factor should be the strongest in its area than the rest of the other factors for it to be valid (Li, 2017). The second part of the DV evaluation was Fornell-Larcker Criterion, a method used to compare the relationship between underlying factors and the square root of the AVE (Hair et al., 2017). This evaluation provides an image of the DV evaluation in which the factor in this area should be stronger than the results of the other factors (Hamid et al., 2017). The third part of the DV evaluation is the

Heterotrait-Monotrait Ratio (HTMT), which measures the average of all index relationships between the factors quantifies other factors. It is one of the tests that must be conducted to overcome the limitations of the Fornell-Larcker Criterion and Cross-Loading assessments. HTMT Validity is weak when the value is greater than 0.9 and becomes stronger as the value decreases from 0.9 (Hair et al., 2017).

3.7.4 Analysis of Structural Model

Assessing the structural model offers researchers the ability to test the capability of a proposed model to predict the associated factors by obtaining the confirmatory results (Hair et al., 2017). In this study, the Path Coefficient for the proposed model and R-Square were tested to confirm the results of the proposed model, which was an extension of the UTAUT model developed by Venkatesh et al. (2003). The Bootstrapping method was used to obtain the Path Coefficient for the factors and validation of the model. Bootstrapping is used initially to measure the ability of indicators to effectively participate in the associated factor when the distribution is normal (Esteva-Armida & Rubio-Sanchez, 2014). The Smart-PLS 3.2 programme was used to evaluate the structural model while the Path Coefficient measures the hypotheses used in describing the factors by showing the p-value and error rate (Hair et al., 2017). Factors that achieve an error ratio of less than 0.05 are considered significant and otherwise (ineffective), when the values are greater than 0.05 (SmartPls, 2020). In addition, the predictive power of the proposed model was measured by using the R^2 Coefficient of Determination.

3.7.4.1 Path Coefficient

Path coefficients are a type of standard version arising from linear regression weights that are used by researchers to determine the potential causal relationship between a group of statistical variables when the research method is SEM (Rahman et al., 2019). Path coefficients are linear regression based on what can be expressed in the following equation (NCSS, 2020):

$$Y j = \beta 0 + \beta 1 X + \varepsilon j$$

As X is the independent variable, Y is the approved variable, and β0 is the Y intercept, β1 is the slope and ε is the error rate. Path coefficients are one of the most reliable methods in the statistical processes of certain disciplines (Drikvand et al., 2011).

Path Coefficient measures the theories used to describe factors by showing the P-Value or error rate (Hair et al., 2017). Theories that yield an error ratio less than 0.05 are considered significant, and otherwise (ineffective), if the values are greater than 0.05 (SmartPls, 2020). The following figure shows the significance table for P-Value (GraaphPad, 2018).

Table 3.3 Path Coefficient Significance Table

P-Value Results	Transpiration	Shortcut
< 0.0001	Extremely significant	****
0.0001 to 0.001	Extremely significant	***
0.001 to 0.01	Very significant	**
0.01 to 0.05	Significant	*
≥ 0.05	Not significant	ns

3.7.4.2 R^2 Coefficient of Determination

One of the most frequently used evaluations in measuring the structural model is the R2 Coefficient of Determination, which measures the strength of the predictive model based on the contained factors (Hair et al., 2017). According to Chin (1998), R^2 value is considered high when it is greater than 0.67, whereas values between 0.33 to 0.67 are considered moderate. On the other hand, if the value is between 0.19 and 0.33, it is considered weak while those less than 0.19 are unacceptable and rejected (Yadgar, 2020). The predictive strength of the model can be expressed by using R^2, which can be represented by the following equation (Frost, 2020):

$$R2 = \frac{variance\ explained\ by\ the\ model}{total\ variance}$$

3.7.5 Smart-PLS Software

Smart-PLS version 3.2.9 software was also used in this study for data analysis. Smart-PLS combines sophisticated statistical methods with an easy-to-use, flexible, and fast user interface (Computer Hope, 2017). There are several reasons for using Smart-PLS, which include the following (Roni, 2014):

1. Certain factors in the proposed model are predictive factors (in addition to confirming other factors which can be used for other applications, such as AMOS).

2. It can be used when the distribution is abnormal.

3. It can be used when elements are associated with less than three factors.

4. Smart-PLS can deal with data extracted from a small sample or a large sample.

3.8 Guideline Development

Based on the results that emerged after the evaluation of the proposed model, a guidelines diagram consisting of the technical factors of the proposed model was developed. The diagram was developed after reviewing several directive illustrations in various fields. The diagram contained all the technical factors with instructions to ensure a successful application of mobile learning. These guidelines were sent to a number of experts who supported the effectiveness of the diagram and its conformity with the findings showing the results of the proposed model and its suitability for use in universities and scientific institutes.

3.9 Chapter Summary

This chapter reviews the scientific tools adopted to compute the required sample size and to analyse the data used by the researcher. These procedures were undertaken to ascertain the validity and effectiveness of the proposed model. Microsoft Excel (2013) spreadsheet was used to extract the respondents' data and to build charts and diagrams showing their descriptive information. A pilot study was carried out to ensure the appropriateness and clarity of the questionnaires before distributing them to the main sample. It is worth noting that the sample here are students of the University of Hail, and data was collected regardless of the difference in the level of experience, courses specifications and the type of devices used. Statistical analysis was conducted using the SEM method through analysis of the measurement model and structural model in which reliability and effectiveness tests were conducted. A number of scientific methods and tools have been addressed in this chapter.

CHAPTER 4

FINDINGS

4.1 Introduction

This chapter highlights the findings of the hypotheses of the proposed model in this study. The hypotheses went through two phases of SEM tests. In the first section, the measurement model tests showed positive indicators in all factors by obtaining high and above-required levels of minimum acceptance. The other section was structural model tests where the results revealed all the factors influencing students' intention to use mobile devices for learning purpose. The exception included three factors whose results showed that they were not positively associated with students' intention to use mobile learning. The most influential general factor was Price Value, which demonstrated that students prioritise the importance of price value of devices with good specifications. For technical factors, the most influential factor was the device performance. This chapter also discusses the nature of the respondents, who were students of University of Hail. Furthermore, this chapter presents the descriptive data of the students participating in this study and the strategies employed by the researcher to ensure that a suitable sample was obtained.

4.2 The Nature of the Respondents

All respondents were students from Hail University. The cultural and age backgrounds of the students varied, as well as their study disciplines. Participation was from both male and female parties and age levels were from the usual university age group to advanced age. The income level of the students varied between participants with very good income and those with weak income to ensure that the views of all parties on the impact of technical factors were considered. In addition, students' locations were recorded, comprising those living in Hail and studying in the main university campus, as well as some who studied in the university-related branches located in the rural areas surrounding Hail.

The focus of the study was on Hail university students due to a number of reasons. First, Arab countries continue to experience technological difficulties that hinder the application of some modern methods (Hamida, 2015), which is one of the barriers to the application of mobile learning. In fact, some students still believe that M-learning is a kind of luxury education that they do not need to care about (Wang & Higgins, 2005) and this may explain the reasons for the low acceptance. Moreover, in some Arab countries, students' acceptance of M-learning is yet to attain the desired level and it is considered somewhat weak (Almaiah et al., 2016). This was reinstated in the context of Saudi Arabia as e-learning studies was described as weak while emphasising the need for further studies and philosophical theorising (Almaiah & Alyoussef, 2019). Therefore, the investigation of M-learning is a foundation to elucidate the factors affecting Saudi students' adoption of mobile learning. Hail University is one of the universities distinguished by the existence of a special deanship for e-learning since its inception (Alharbi et al., 2017), thus, indicating the institution's massive achievements in the field of mobile education. Therefore, the focus of the study was on Hail University students to investigate how technical factors affect their acceptance of mobile learning.

4.3 Descriptive Data Analysis

Data collected from the questionnaires distributed to students showed the participation of different categories of university students. The proportion of participating males was 38% and females 62% as shown in Figure 4.6.

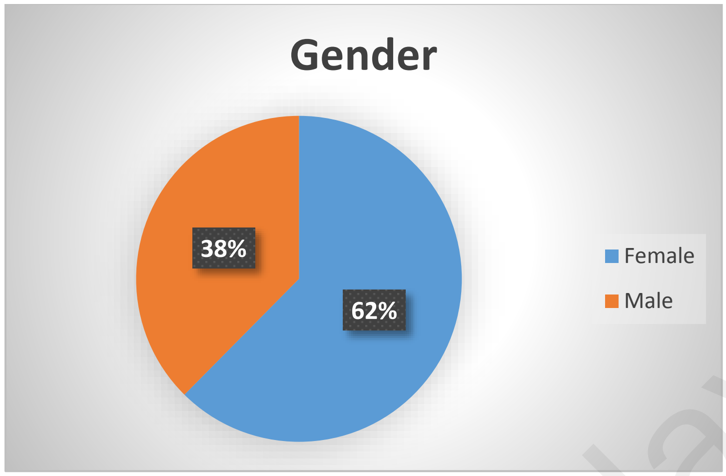

Figure 4.1 Gender Specification

The majority of the participating students (65%) were between 20 to 24 years old, whereas the least (10%) were between the age of 25 and 29 years old as shown in Figure 4.2.

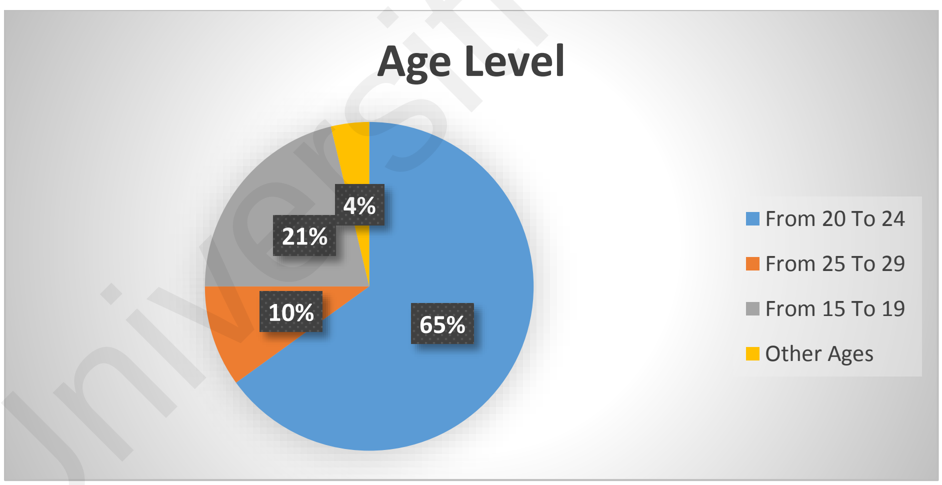

Figure 4.2 Age Distribution

The proportions of students having poor, medium and very good income levels were almost equal (Figure 4.3). However, few of the students had low income levels compared to other categories of respondents. This might be due to the fact that public university education is free in Saudi Arabia as the average monthly family income was reported to be 11.984 riyals, amounting to 2485 riyals per person (Saudi General Authority for Statistics, 2018).

Figure 4.3 Income Levels

Most of the participating students (71%) were living in Hail city, followed by those living in the villages around Hail. Also, 90% of the respondents were in the main campus of the university (Figure 4.4). As Hail University accepts Saudi and non-Saudi students, there were participations from a number of students residing outside Hail and its villages. This diversity of students' backgrounds and residential places were due to the large number of students studying at Hail University.

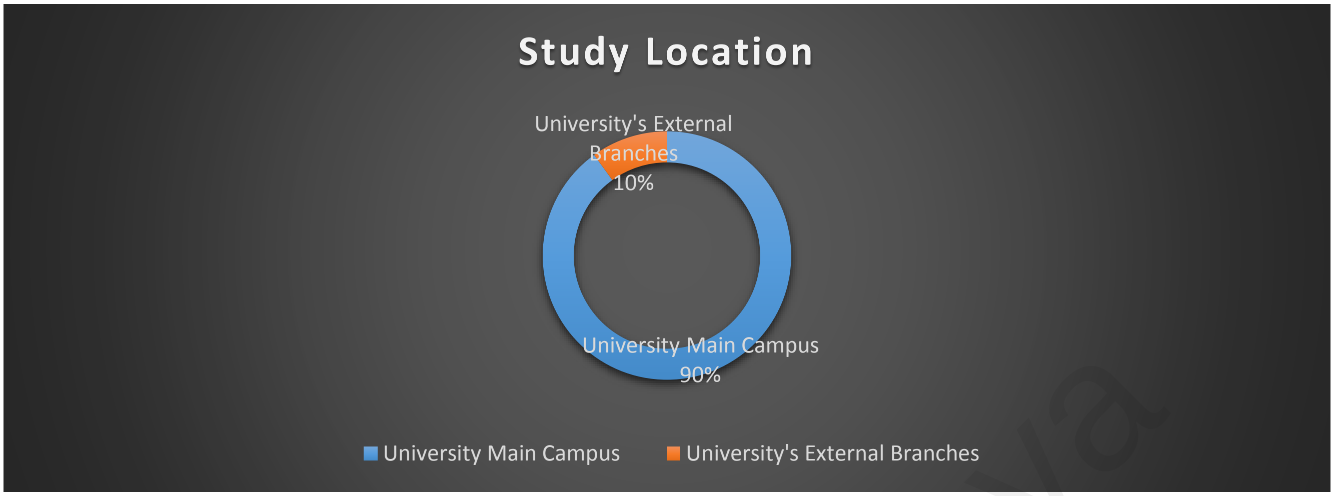

Figure 4.4 Place of Study

The results showed that majority of the participants came from students studying in the main campus of the university (Figure 4.4). This finding might be due to the fact that the percentage of students studying in the branches was low with an exodus of villagers coming to the city to study at the university. In terms of college participation, students from different colleges and specialties participated in the study. Most of the participating students were from the Faculty of Education and the Faculty of Arts and Science. In terms of study levels, the preparatory students emerged with the highest number of participants (Appendix E). The descriptive analysis is summarised in Table 4.1:

Table 4.1 Descriptive Analysis

CHARACTERS		FREQUENCY	PERCENT (%)
GENDER	*Male*	230	38%
	Female	382	62%
AGE LEVEL	*From 15 To 19*	130	21%
	From 20 To 24	398	65%
	From 25 To 29	61	10%
	Other Age	23	4%
INCOME	*Very Good*	164	27%
	Good	210	34%
	Medium	190	31%
	Poor	48	8%
STUDY LOCATION	*University Main Campus*	551	90%
	University's External Branches	61	10%

4.4 Assumption of Normality

Normality test is a supplement for the graphical assessment of the state of nature (Elliott & Woodward, 2007). These tests are used to determine the normal distribution of samples on which studies and research are conducted. Although it is important to conduct such tests, there are a number of statements that demand for no such tests if SEM-PLS is used, which was the case in this study. For instance, normality is not needed when applying linear regression test (Lumley et al., 2002). Data obtained in this study was analysed using the SmartPLS programme, which is advantageous in handling either normal or non-normal distributed data (Roni, 2014). However, the data were tested for the assumptions of normality to ensure more reliability and confidence. The level of skewness and kurtosis were assessed to determine if the data conformed to normality tests. The acceptable values for skewness range from -3 to +3 (Brown, 2006), whereas values between

-10 to +10 are acceptable for kurtosis (Megan & Trisha, 2013). All the data considered in this study demonstrated acceptable level of kurtosis and skewness as in (Appendix J).

4.5 Testing of the Measurement Model

The analysis of the measurement model entailed two stages. The first stage was convergent validity comprising three sections: Average Variance Extracted (AVE), Composite Reliability (CR), and Cronbach's Alpha. The second stage was Discriminate Validity (DV), which consists of Fornell-Larcker Criterion, Cross-Loadings, and Heterotrait-Monotrait Ratio (HTMT) tests. It is important to note that the presented results of the measurement model was for the pilot study sample, whereas that of the measurement analysis for the main sample is available in appendix I. Both findings showed acceptable results and they were all within their acceptable range and varied in strength and effectiveness between a number of general and technical factors.

4.5.1 Measurement of the General Factors

The results showed that Cronbach's Alpha test was all above 0.5 and at the acceptable minimum for tested factors. The highest factor in validity was Effort Expectancy with 0.936, followed by Performance Expectancy with 0.879, whereas Social Influence and Price Value obtained 0.872 and 0.834, respectively. All the Cronbach's Alpha values were close to 1, which indicates the acceptable level of internal consistency and high reliability. Nevertheless, it has been suggested that it is better not to rely on Cronbach's Alpha alone and to perform other supporting tests (Hair et al., 2017).

Hence, Composite Reliability test was performed and the result was acceptable and satisfactory as the value was 0.81, which is higher than 0.6. The highest of these factors was Effort Expectancy with 0.959, followed by Social Influence with 0.921, whereas Performance Expectancy and Price Value achieved 0.911, and 0.900, respectively. These results demonstrated high validity and reliability of general factors as all the values were above 0.9 and close to 1, which is the maximum reliability limit in this test. The third step of the validity test for the proposed model was Average Variance Extracted (AVE) and the values were between 0.65 and 0.89, which is considered to be highly reliable as shown in Table 4.2.

Table 4.2 Convergent Validity

	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Effort Expectancy	0.936	0.959	0.887
Performance Expectancy	0.879	0.911	0.673
Price Value	0.834	0.900	0.750
Social Influence	0.872	0.921	0.797

The results of the second phase of the measurement model testing based on the Fornell-Larcker Criterion, Cross-Loadings, and HTMT are summarised in Table 4.3. In Cross-Loadings, a factor must be the strongest among the factors during testing in its area for it to be highly relevant and reliable. All the general factors had the strongest impact in their region by having the highest results compared to other factors. Performance Expectancy results ranged from 0.871 to 0.745, indicating high reliability and validity. The results for Effort Expectancy items were between 0.932

and 0.958 while Price Value were between 0.929 and 0.802. In addition, the results of Social Influence and Price Value were similar as their values ranged from 0.924 to 0.858.

Table 4.3 Items Cross Loadings

	DC	DCO	DM	DP	DPP	EE	IU	NC	NS	PE	PV	SRML	SI
Effort Expectancy	0.501	0.568	0.395	0.590	0.395	0.932	0.431	0.349	0.442	0.628	0.307	0.540	0.248
	0.496	0.657	0.368	0.636	0.383	0.936	0.408	0.339	0.442	0.565	0.393	0.522	0.287
	0.635	0.603	0.446	0.613	0.400	0.958	0.492	0.381	0.553	0.676	0.353	0.618	0.318
Performance Expectancy	0.658	0.519	0.418	0.605	0.389	0.669	0.372	0.406	0.570	0.791	0.289	0.545	0.352
	0.613	0.629	0.510	0.708	0.508	0.590	0.553	0.527	0.595	0.871	0.483	0.459	0.355
	0.560	0.526	0.386	0.575	0.362	0.559	0.605	0.442	0.483	0.849	0.335	0.489	0.510
	0.625	0.465	0.505	0.610	0.464	0.416	0.474	0.495	0.514	0.745	0.487	0.411	0.434
	0.591	0.564	0.438	0.756	0.418	0.522	0.513	0.575	0.439	0.841	0.313	0.407	0.607
Price Value	0.312	0.333	0.418	0.290	0.376	0.155	0.411	0.350	0.343	0.255	0.802	0.430	0.376
	0.513	0.629	0.652	0.482	0.591	0.422	0.538	0.544	0.728	0.482	0.863	0.547	0.262
	0.546	0.571	0.527	0.475	0.551	0.352	0.616	0.513	0.612	0.445	0.929	0.562	0.376
Social Influence	0.368	0.406	0.442	0.469	0.342	0.228	0.547	0.366	0.325	0.501	0.398	0.418	0.894
	0.484	0.481	0.426	0.496	0.389	0.254	0.495	0.420	0.356	0.494	0.316	0.508	0.924
	0.438	0.472	0.436	0.512	0.311	0.342	0.446	0.389	0.346	0.493	0.311	0.442	0.858

** Device Compatibility = DC, Device Connectivity = DCO, Device Memory = DM, Device Performance = DP, Device Processing Power = DPP, Effort Expectancy = EE, Intention to Use = IU, Network Coverage = NC, Network Speed = NS, Performance Expectancy = PE Price Value = PV, Security and Reliability of Mobile Learning on Devices = SRML, Social Influence = SI

From the Fornell-Larcker Criterion results, each of the factor in the area was stronger than the remaining factors, either on the left or below it as shown in Table 4.4.

Table 4.4 Fornell-Larcker Criterion

	DC	DCO	DM	DP	DPP	EE	IU	NC	NS	PE	PV	SRML	SI
Device Compatibility	0.938												
Device Connectivity	0.704	0.827											
Device Memory	0.692	0.597	0.863										
Device Performance	0.644	0.690	0.534	0.945									
Device Processing Power	0.682	0.645	0.695	0.495	0.814								
Effort Expectancy	0.582	0.645	0.430	0.650	0.417	**0.942**							
Intention to Use	0.708	0.666	0.649	0.505	0.616	0.474	0.914						
Network Coverage	0.626	0.600	0.657	0.567	0.468	0.379	0.611	0.725					
Network Speed	0.748	0.684	0.730	0.597	0.627	0.512	0.652	0.681	0.938				
Performance Expectancy	0.734	0.660	0.547	0.792	0.520	0.664	0.626	0.597	0.628	**0.821**			
Price Value	0.542	0.605	0.620	0.491	0.594	0.372	0.613	0.551	0.666	0.467	**0.866**		
Security and Reliability of Mobile Learning on Devices	0.697	0.685	0.636	0.501	0.661	0.598	0.683	0.520	0.663	0.557	0.598	0.808	
Social Influence	0.479	0.505	0.487	0.550	0.390	0.303	0.559	0.438	0.382	0.556	0.386	0.509	***0.892***

** Device Compatibility = DC, Device Connectivity = DCO, Device Memory = DM, Device Performance = DP, Device Processing Power = DPP, Effort Expectancy = EE, Intention to Use = IU, Network Coverage = NC, Network Speed = NS, Performance Expectancy = PE Price Value = PV, Security and Reliability of Mobile Learning on Devices = SRML, Social Influence = SI

For HTMT test, values less than 0.9 are considered within the acceptable level of validity and reliability. The results of the HTMT are summarised in Table 4.5, which revealed that the values of all the factors were smaller than 0.9, indicating the effectiveness of the measurement model.

Table 4.5 Heterotrait-Monotrait Ratio (HTMT)

	DC	DCO	DM	DP	DPP	EE	IU	NC	NS	PE	PV	SRML	SI
Device Compatibility													
Device Connectivity	0.866												
Device Memory	0.835	0.762											
Device Performance	0.717	0.812	0.613										
Device Processing Power	0.799	0.812	0.814	0.553									
Effort Expectancy	**0.639**	**0.767**	**0.494**	**0.693**	**0.469**								
Intention to Use	0.784	0.789	0.741	0.546	0.690	0.508							
Network Coverage	0.791	0.792	0.858	0.684	0.585	0.454	0.771						
Network Speed	0.869	0.838	0.879	0.663	0.730	0.565	0.731	0.846					
Performance Expectancy	**0.849**	**0.790**	**0.649**	**0.873**	**0.597**	**0.737**	**0.687**	**0.750**	**0.729**				
Price Value	**0.621**	**0.733**	**0.744**	**0.542**	**0.685**	**0.406**	**0.696**	**0.695**	**0.761**	**0.529**			
Security and Reliability of Mobile Learning on Devices	0.818	0.854	0.772	0.563	0.792	0.673	0.783	0.670	0.779	0.661	0.707		
Social Influence	**0.549**	**0.605**	**0.574**	**0.611**	**0.453**	**0.339**	**0.627**	**0.585**	**0.440**	**0.629**	**0.453**	**0.600**	

** Device Compatibility = DC, Device Connectivity = DCO, Device Memory = DM, Device Performance = DP, Device Processing Power = DPP, Effort Expectancy = EE, Intention to Use = IU, Network Coverage = NC, Network Speed = NS, Performance Expectancy = PE Price Value = PV, Security and Reliability of Mobile Learning on Devices = SRML, Social Influence = SI

4.5.2 Measurement of the Technical Factors

The results of the measurement model of the technical factors indicated high reliability and validity in all elements, with varying strengths in each of them compared to the other elements. Device Performance ranked first, followed by Device Compatibility, Network Speed, Device Processing Power, Device Memory, Security and Reliability of Mobile Learning on Devices, and Device Connectivity. Network Coverage ranked last with 0.688, which was still above the acceptable level. This means that the validity and effectiveness of the factors were strong. Composite Reliability tests also demonstrated the validity of all technical factors with overall results above 0.8. The highest result was received by Device Performance, i.e., 0.959, which means that the factor was highly reliable and valid.

The lowest result in this test was for Network Coverage with 0.812, which is still significantly higher than the minimum acceptance rate for this type of test. The third stage of convergent validity was AVE test, which showed the results outweighed the technical factors in this test with most elements yielding high reliability and validity outcomes. The highest and lowest value obtained in the test was for Device Performance (0.892) and Network Coverage (0.525), respectively. However, the latter result is still above the minimum acceptable validity in the AVE test. Table 4.6 shows the results of the Convergent Validity of Technical Factors.

Table 4.6 Convergent Validity of Technical Factors

	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Device Compatibility	0.865	0.936	0.879
Device Connectivity	0.766	0.866	0.685
Device Memory	0.827	0.897	0.745
Device Performance	0.939	0.961	0.892
Device Processing Power	0.831	0.887	0.663
Network Coverage	0.688	0.812	0.525
Network Speed	0.864	0.936	0.880
Security and Reliability of Mobile Learning on Devices	0.822	0.882	0.653

Table 4.7 shows the results of the Discrimination Validity phase test. Similarly, the values indicated high levels of reliability and overall validity. Cross-Loadings for technical factors showed that all factors in their region were stronger than other factors except one item, which was retained for having a value above 0.5 in outer loading and shows good result in other tests (Sujit & Rajesh, 2016). Cross-Loadings is important when studying each factor's items to determine their strengths and to suitability in drawing conclusions from the proposed model.

Table 4.7 Cross Loadings of Technical Factors

	DC	DCO	DM	DP	DPP	EE	IU	NC	NS	PE	PV	SRML	SI
Device Compatibility	0.920	0.669	0.711	0.608	0.682	0.525	0.563	0.639	0.726	0.651	0.503	0.616	0.409
	0.955	0.656	0.604	0.603	0.610	0.564	0.743	0.550	0.687	0.719	0.515	0.685	0.481
Device Connectivity	0.647	0.908	0.545	0.601	0.524	0.556	0.642	0.548	0.602	0.656	0.568	0.648	0.549
	0.580	0.841	0.409	0.693	0.475	0.571	0.515	0.583	0.667	0.639	0.529	0.530	0.427
	0.513	0.722	0.527	0.410	0.619	0.477	0.479	0.346	0.420	0.310	0.390	0.510	0.240
Device Memory	0.630	0.499	0.923	0.490	0.674	0.352	0.636	0.558	0.606	0.515	0.536	0.538	0.433
	0.509	0.479	0.868	0.366	0.648	0.351	0.554	0.510	0.514	0.417	0.539	0.519	0.442
	0.666	0.587	0.793	0.540	0.456	0.428	0.477	0.655	0.806	0.489	0.539	0.606	0.385
Device Performance	0.558	0.664	0.486	0.929	0.391	0.601	0.464	0.568	0.550	0.723	0.482	0.448	0.539
	0.602	0.664	0.506	0.973	0.494	0.658	0.509	0.526	0.578	0.783	0.485	0.478	0.498
	0.667	0.627	0.524	0.931	0.516	0.579	0.456	0.513	0.565	0.736	0.423	0.494	0.524
Device Processing Power	0.550	0.503	0.560	0.323	0.823	0.264	0.592	0.300	0.406	0.391	0.537	0.503	0.271
	0.498	0.520	0.595	0.448	0.846	0.347	0.486	0.384	0.548	0.421	0.454	0.493	0.335
	0.433	0.438	0.415	0.280	0.833	0.261	0.375	0.237	0.338	0.260	0.369	0.480	0.252
	0.704	0.616	0.653	0.542	0.752	0.477	0.501	0.577	0.721	0.584	0.531	0.663	0.403
Network Coverage	0.550	0.597	0.534	0.505	0.452	0.424	0.437	0.702	0.700	0.551	0.513	0.452	0.383
	0.155	0.142	0.225	0.160	0.099	0.021	0.309	0.529	0.015	0.194	0.114	0.178	0.333
	0.482	0.327	0.464	0.399	0.319	0.231	0.492	0.799	0.422	0.403	0.357	0.387	0.273
	0.549	0.603	0.618	0.516	0.425	0.359	0.506	0.830	0.703	0.530	0.538	0.446	0.312
Network Speed	0.739	0.665	0.729	0.578	0.587	0.496	0.634	0.680	0.943	0.568	0.647	0.634	0.386
	0.662	0.616	0.637	0.541	0.589	0.464	0.587	0.594	0.933	0.611	0.600	0.609	0.329
Security and Reliability of Mobile Learning on Devices	0.560	0.554	0.535	0.484	0.421	0.493	0.608	0.521	0.608	0.469	0.556	0.764	0.472
	0.543	0.505	0.418	0.338	0.448	0.430	0.474	0.439	0.516	0.468	0.405	0.814	0.407
	0.518	0.516	0.499	0.340	0.579	0.468	0.536	0.257	0.406	0.357	0.418	0.791	0.391
	0.622	0.624	0.580	0.434	0.682	0.526	0.569	0.449	0.593	0.500	0.528	0.860	0.368

** Device Compatibility = DC, Device Connectivity = DCO, Device Memory = DM, Device Performance = DP, Device Processing Power = DPP, Effort Expectancy = EE, Intention to Use = IU, Network Coverage = NC, Network Speed = NS, Performance Expectancy = PE Price Value = PV, Security and Reliability of Mobile Learning on Devices = SRML, Social Influence = SI

On the other hand, the results of the Fornell-Larcker Criterion test were all at the satisfactory level (Table 4.8). The results were generally between 0.945 and 0.725 for all technical factors, which when represented in a table were clearly stronger than those of the factors on the left or below.

Table 4.8 Fornell-Larcker Criterion of Technical Factors

	DC	DCO	DM	DP	DPP	EE	IU	NC	NS	PE	PV	SRML	SI
Device Compatibility	***0.938***												
Device Connectivity	0.704	***0.827***											
Device Memory	0.692	0.597	***0.863***										
Device Performance	0.644	0.690	0.534	***0.945***									
Device Processing Power	0.682	0.645	0.695	0.495	***0.814***								
Effort Expectancy	0.582	0.645	0.430	0.650	0.417	0.942							
Intention to Use	0.708	0.666	0.649	0.505	0.616	0.474	0.914						
Network Coverage	0.626	0.600	0.657	0.567	0.468	0.379	0.611	***0.725***					
Network Speed	0.748	0.684	0.730	0.597	0.627	0.512	0.652	0.681	***0.938***				
Performance Expectancy	0.734	0.660	0.547	0.792	0.520	0.664	0.626	0.597	0.628	0.821			
Price Value	0.542	0.605	0.620	0.491	0.594	0.372	0.613	0.551	0.666	0.467	0.866		
Security and Reliability of Mobile Learning on Devices	0.697	0.685	0.636	0.501	0.661	0.598	0.683	0.520	0.663	0.557	0.598	***0.808***	
Social Influence	0.479	0.505	0.487	0.550	0.390	0.303	0.559	0.438	0.382	0.556	0.386	0.509	0.892

** Device Compatibility = DC, Device Connectivity = DCO, Device Memory = DM, Device Performance = DP, Device Processing Power = DPP, Effort Expectancy = EE, Intention to Use = IU, Network Coverage = NC, Network Speed = NS, Performance Expectancy = PE Price Value = PV, Security and Reliability of Mobile Learning on Devices = SRML, Social Influence = SI

The final stage of the Discriminate Validity test was the Heterotrait-Monotrait Ratio (HTMT) assessment, which is occasionally applied to cover other limitations of testing related to validity and reliability. In this test, the lower the factor result, which is less than 0.9, the better its reliability and validity. Most of the technical factors had values that ranged from 0.600 to 0.866, therefore, indicating the validity and reliability of these factors as shown in Table 4.9.

Table 4.9 Heterotrait-Monotrait Ratio

	DC	DCO	DM	DP	DPP	EE	IU	NC	NS	PE	PV	SRML	SI
Device Compatibility													
Device Connectivity	0.866												
Device Memory	0.835	0.762											
Device Performance	0.717	0.812	0.613										
Device Processing Power	0.799	0.812	0.814	0.553									
Effort Expectancy	0.639	0.767	0.494	0.693	0.469								
Intention to Use	0.784	0.789	0.741	0.546	0.690	0.508							
Network Coverage	0.791	0.792	0.858	0.684	0.585	0.454	0.771						
Network Speed	0.869	0.838	0.879	0.663	0.730	0.565	0.731	0.846					
Performance Expectancy	0.849	0.790	0.649	0.873	0.597	0.737	0.687	0.750	0.729				
Price Value	0.621	0.733	0.744	0.542	0.685	0.406	0.696	0.695	0.761	0.529			
Security and Reliability of Mobile Learning on Devices	0.818	0.854	0.772	0.563	0.792	0.673	0.783	0.670	0.779	0.661	0.707		
Social Influence	0.549	0.605	0.574	0.611	0.453	0.339	0.627	0.585	0.440	0.629	0.453	0.600	

** Device Compatibility = DC, Device Connectivity = DCO, Device Memory = DM, Device Performance = DP, Device Processing Power = DPP, Effort Expectancy = EE, Intention to Use = IU, Network Coverage = NC, Network Speed = NS, Performance Expectancy = PE Price Value = PV, Security and Reliability of Mobile Learning on Devices = SRML, Social Influence = SI

Overall, the tests and evaluations conducted on the measurement model showed superiority in all general and technical factors with associated elements. The outcomes revealed high levels of reliability and validity, thereby, reflecting in the success of the measurement model and its suitability for the tested sample.

4.6 Testing of the Structural Model

In order to determine the effects of the independent variables on dependent variables in PLS-SEM of the proposed models, Path Coefficient and R2 Coefficient of Determination tests were conducted to confirm the validity and effectiveness of the models. Path Coefficient produces results that indicate the P-Value of the hypotheses contained in the proposed models and showing the impact of the relationship between the two tested variables. In this study, R^2 Coefficient of Determination showed indicated the model's predictive strength of the factors affecting students' intention to use mobile education. The measurement of structural model was based on main sample results.

4.6.1 Measurement of the General Factors

The educational process over recent years has evolved to become a diverse source of learning, allowing learners to easily access information from various sources. One of the most recent sources of educational learning is via mobile devices, or what is referred to as M-learning. This study was applied to a Saudi public university; the University of Hail and the results obtained from the tests conducted on the proposed model were both good and influential. Specifically, the findings revealed the support of nine out of the 12 hypotheses presented by the proposed model in this thesis. The results of this study are comparable to the reports in the UTAUT original model. For instance, in the presence of some moderators, the effect of Performance Expectancy (PE) in the original model was found to be stronger for men and young workers (Venkatesh et al., 2003). Meanwhile, in the proposed model in this study, there was a clear effect of PE on the intention of students to use mobile devices in the educational process.

Furthermore, Venkatesh et al., (2003) found that Effort Expectancy (EE) had a stronger influence on the original model of some user classes considering the presence of some moderators (Venkatesh et al., 2003). This factor was also indicated to influence the proposed model on the students' intention to use M-learning. In contrast, Social Influence (SI) was not identified as an influential factor in this study. This contradicts the findings of Venkatesh et al. (2003), who stated in the original model that EE affected some groups, such as the elderly and women while influencing their intention to use.

4.6.2 Measurement of the Technical Factors

Regarding the technical factors that were the primary focus of this study, the results showed the influence of most of these factors on the extent of students' acceptance on the inclusion of M-learning in their study life. The strongest of these factors were Network Speed, Device Performance, and Device Compatibility, where their influence was very high and noticeably significant. The remaining factors ranged between having a moderate effect and an acceptable influence, which included Network Coverage, Device Memory, and Device Connectivity as shown in Figure 4.5.

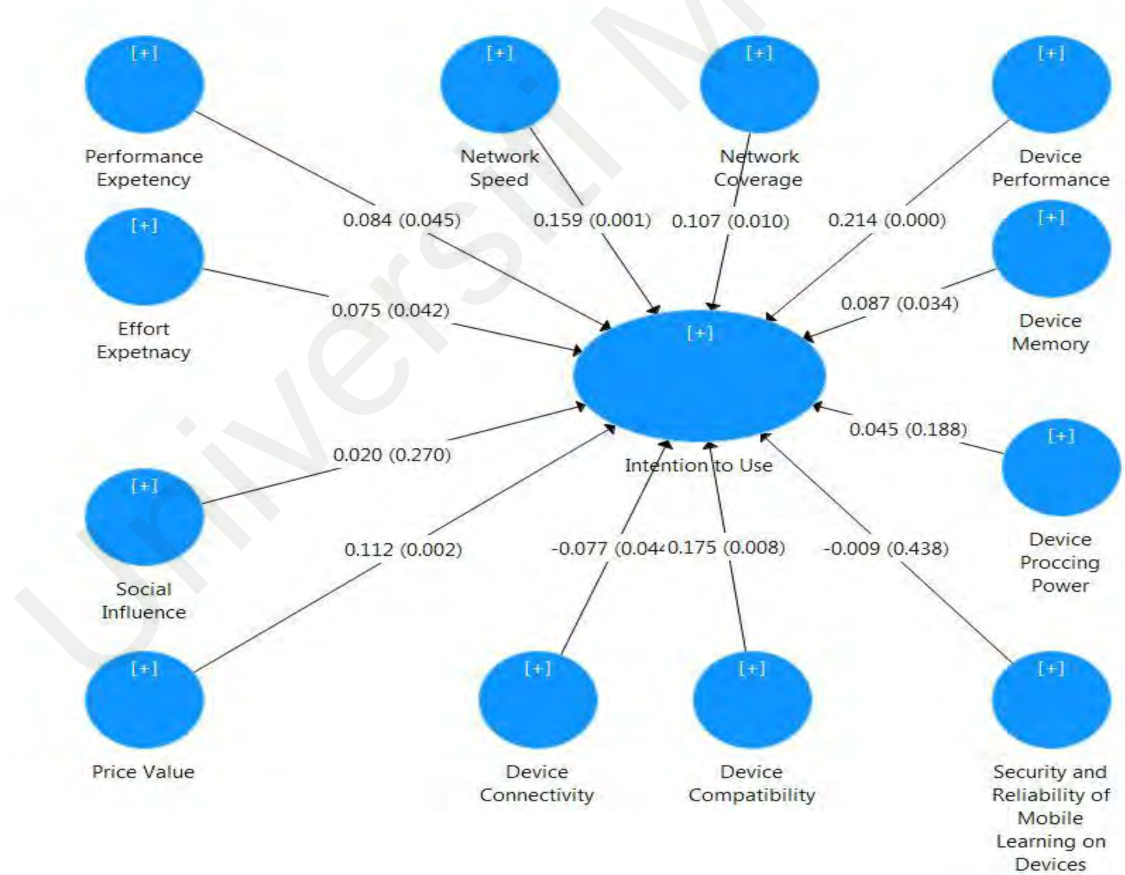

Figure 4.5 Model Path Coefficient

The exceptions that were noted in this study included Security and Reliability of M-learning on Devices and Device Processing Power as these factors did not affect the students' intention towards M-learning. This may be due to two reasons, one of which is that educational materials may neither always have heavy programmatic or graphic characteristics nor require a powerful processor. Also, the other reason may be that universities and educational institutions freely and securely provide many educational materials to students, so that they may not need to worry regarding security and reliability. However, Price Value and its impact on students' intention to include M-learning in their scientific lives was very high. This might be due to the diversity of students' income levels and standard of living. Overall, the relationships of the hypotheses are presented in Table 4.10.

Table 4.10 Hypotheses Relationships Result

	P Values	Status
Device Compatibility -> Intention to Use	0.008	supported
Device Connectivity -> Intention to Use	0.044	supported
Device Memory -> Intention to Use	0.034	supported
Device Performance -> Intention to Use	0.000	supported
Device Processing Power -> Intention to Use	0.188	not supported
Effort Expectancy -> Intention to Use	0.042	supported
Network Coverage -> Intention to Use	0.010	supported
Network Speed -> Intention to Use	0.001	supported
Performance Expectancy -> Intention to Use	0.045	supported
Price Value -> Intention to Use	0.002	supported
Security and Reliability of Mobile Learning on Devices -> Intention to Use	0.438	not supported
Social Influence -> Intention to Use	0.270	not supported

4.7 Validity of the Proposed Model

The validity of the proposed model was successful as 63% of the variance of factors affecting Intention to use M-learning was described as shown in Table 4.11. According to Chin (1998), a model is considered to be highly represented for what it is built for if the R^2 value is higher than 0.67 (Yadgar, 2020). The rate obtained by the proposed model in this study was close to the high level, which was separated with only a few minor degrees. In addition, the model succeeded in obtaining high levels of reliability and validity in measurement model tests, many of which were higher than the minimum acceptance level. Among the 12 hypotheses built for this model, nine succeeded in demonstrating a significant influence on students' intention to use mobile learning.

Table 4.11 Coefficient of Determination R^2

R-Square of the Endogenous Latent Variables		
Constructs Relation	**R^2**	**Result**
Intention to Use	0.632	Moderate*
• *R^2 < 0.33 → Weak* • *R^2 = 0.33 to 0.67 → Moderate* • *R^2 > 0.67 → High*		

The proposed model had better R^2 rate compared to other related models in M-learning field. Overall, the R^2 rates in previous studies ranged from 47.1% to 54% (Israel, 2019; Thomas et al., 2013; Chao, 2019), which are lower than the value obtained in the present study. In fact, Chaka and Govender (2017) reported R^2 value of 38.6%, which is considered very low but still at an acceptable level. As a result, the model suggested in this study can be considered the best when compared to these earlier models.

4.8 Chapter Summary

This chapter shows the demographic characteristics of the students participating in this study, namely students of Hail University. Most of the responses came from a large number of students studying either at the university's main campus or its branches. Furthermore, the metadata showed the diversity of students' accommodation and income. Analytical tests affirmed that the proposed model is suitable and strongly predicts the factors affecting students' intention to use M-learning with a good R^2 rating. Nine hypotheses were confirmed to positively influence students' intention to use M-learning and they had varying strengths of association with the outcome. However, the social factor, devices' security aspect and processing power had no significant impact on the intention of students to use their mobile devices in the educational process. In general, the model proposed in this study yielded positive results and strong indicators, which surpassed several previous models regarding M-learning (Appendix F).

CHAPTER 5

DISCUSSION

Several models have studied users' intention to use technology in their daily lives. Amongst these models, the most commonly used were TAM and the UTAUT (Dajani & Yaseen, 2016). It has been established that UTAUT remains the best model that effectively measures technology acceptance (Chao, 2019). Therefore, the model proposed in this study extended the UTAUT theory by including technical factors as the aspect has not been explored with regards to student' adoption of using their mobile devices in education. In comparison to models that used either the UTAUT or other theories, this model succeeded in bridging the knowledge gap on the impact of technical factors on students' acceptance of mobile learning. Many of the earlier models were based solely on the use and application of well-known theories without modifications or extensions. Despite several studies have attempted to extend some well-known models, technical factors is yet to be considered, especially in research designed to assess students' acceptance of technology.

5.1 The Effects of General Factors

The results of the general factors were generally supportive and influenced students' intention to use their devices for mobile learning. Three hypotheses had good p-value rates, while Social Influence had no significant impact on students' intentions to engage in mobile learning.

5.1.1 Performance Expectancy

This study found that Performance Expectancy achieved good results in both stages of the SEM tests. Performance Expectancy results in measurement model were good and acceptable indicators as shown in the table below:

Table 5.1 Performance Expectancy Results

<table>
<tr><td rowspan="6">Measurement Model Results</td><td colspan="3">Convergent Validity</td></tr>
<tr><td>Cronbach's Alpha</td><td>Composite Reliability</td><td>Average Variance Extracted (AVE)</td></tr>
<tr><td>0.879</td><td>0.911</td><td>0.673</td></tr>
<tr><td colspan="3">Discriminant Validity</td></tr>
<tr><td>Cross Loadings</td><td>Fornell-Larcker Criterion</td><td>HTMT</td></tr>
<tr><td>0.791
0.871
0.849
0.745
0.841</td><td>0.821</td><td>0.729</td></tr>
<tr><td rowspan="2">Structural Model Results</td><td colspan="3">Path Coefficient (P-Value)</td></tr>
<tr><td colspan="3">0.045</td></tr>
<tr><td colspan="4">Performance Expectancy</td></tr>
</table>

Furthermore, the relationship between Performance Expectancy and the intention of use was positively influenced based on the P-value which was 0.045. This result is consistent with several previous studies, reporting the influence of Performance Efficiency on mobile technology (Azizi and Khatony, 2019; Nassuora, 2013; Akinbode et al., 2018; Chaka and Govender, 2017; Almaiah et al., 2019; Naveed et al., 2020; Chao, 2019; Olumuyiwa et al., 2020). These results illustrate the significance of Performance Expectancy is in predicting whether students are likely to accept and use M-learning. Although the relationship was not strong and influential in the original UTAUT model (Masrom & Hussein, 2008), this study and many others had shown that there is a positive and influential relationship between these two factors. The reason why they did not affect the original model might be due to some effects that had led to a weak or non-existent relationship. It is worth mentioning that Performance Expectancy and Effort Expectancy in UTAUT are an extension of Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) factors in TAM model because UTAUT was based on several theories, including TAM (Masrom & Hussein, 2008).

5.1.2 Effort Expectancy

The analysis of the proposed model showed good results obtained by Effort Expectancy in measurement model and structural model tests. These results indicated how strong the relationships of this factor were represented. In the same vein, the result of the path coefficient reflected a positive relationship between Effort Expectancy and the students' intention to use M-learning that matched with the results obtained in the original model (Masrom & Hussein, 2008). In addition, when comparing these results with several other research in the field of mobile learning, Effort Expectancy was reported to have a significant impact in most of these studies (Chaka & Govender, 2017; Nassuora, 2013; Chao, 2019; Akinbode et al., 2018; Olumuyiwa et al., 2020; Almaiah et al., 2019).

Table 5.2 Effort Expectancy Results

Measurement Model Results	***Convergent Validity***		
	Cronbach's Alpha	*Composite Reliability*	*Average Variance Extracted (AVE)*
	0.936	**0.959**	**0.887**
	Discriminant Validity		
	Cross Loadings	*Fornell-Larcker Criterion*	*HTMT*
	0.932 **0.936** **0.958**	**0.942**	**0.469**
Structural Model Results	*Path Coefficient (P-Value)*		
	0.042		
Effort Expectancy			

Furthermore, some studies that used TAM found that PEOU (i.e., the equivalent of UTAUT Model) of Effort Expectancy factor also influenced students' intention to use mobile learning (Alshurideh et al., 2019; Naveed et al., 2020). In contrast, some studies reported that Effort Expectancy had no significant impact on M-learning (Thomas et al., 2013; Israel, 2019) and these findings might be due to the circumstances in which these studies were conducted.

5.1.3 Social Influence

In the first part of the analysis results, Social Influence demonstrated good outcomes in the measurement model as shown in the following table:

Table 5.3 Social Influence Results

Measurement Model Results	***Convergent Validity***		
	Cronbach's Alpha	*Composite Reliability*	*Average Variance Extracted (AVE)*
	0.872	**0.921**	**0.797**
	Discriminant Validity		
	Cross Loadings	*Fornell-Larcker Criterion*	*HTMT*
	0.894 **0.924** **0.858**	**0.892**	**0.600**
Structural Model Results	*Path Coefficient (P-Value)*		
	0.270		
Social Influence			

However, there was no relationship between the social factor and students' willingness to use M-learning. Although the results were not compatible with the original model (Masrom & Hussein, 2008), several other studies have also reported similar findings as observed in the present study (Naveed et al., 2020; Akinbode et al., 2018; Almaiah et al., 2019; Chaka and Govender, 2017). There are many reasons why Social Influence was ineffective in the aforementioned studies. It might be due to the absence of mobile education in most of the countries where the studies were conducted. This is particularly true in developing countries where many individuals are not conversant with this kind of modern way of obtaining information. Moreover, new life and a plethora of technological means might have reduced the role of social factors, their impacts on individual decisions and their overall lifestyle. Furthermore, previous studies have shown that technology infrastructure and some of its successes vary from one country to another. This explains why it might affect social awareness and popular cultures, which in turn affects Social Influence, resulting in its strong or weak impact in society.

5.1.4 Price Value

The results of this factor were good at the two phases of the tests conducted in this study. In measurement model performance, the results indicated the strength of Price Value and the representation of the elements associated with its hypothesis. Also, the factor demonstrated a p-value of 0.002, which indicated a high-level effect on students' intention to use mobile learning (Table 5.4).

Table 5.4 Price Value Results

Measurement Model Results	***Convergent Validity***		
	Cronbach's Alpha	*Composite Reliability*	*Average Variance Extracted (AVE)*
	0.834	**0.900**	**0.750**
	Discriminant Validity		
	Cross Loadings	*Fornell-Larcker Criterion*	*HTMT*
	0.802 **0.863** **0.929**	**0.866**	**0.529**
Structural Model Results	*Path Coefficient (P-Value)*		
	0.002		
Price Value			

Although Price Value came in a later extension of the original model, the financial value of technological applications may affect users' willingness to acquire certain technological means or their applications (Venkatesh et al., 2012). Compared to some previous studies in the field of mobile learning, the results of this study matched with theirs in terms of the strength and impact of this factor (Venkatesh et al., 2012; Shuiqing, 2013). Other studies used another term for the factor, which is the Perceived Price and also demonstrated a similar result (Yu-Yin et al., 2018). In contrast, Kang et al. (2015) reported that Price Value does not have that effect on the acceptance of M-learning. The disparity in the results might be due to methods used in the various studies, studied population and circumstances under which the research was conducted.

5.2 The Effects of Technical Factors

This study aimed to highlight technical factors and assess their predictability they were and impact on students' acceptance of mobile learning. There are limited studies regarding the importance of technical factors in the acceptance of M-learning. Hence, this study extended the UTAUT model by including technical factors. Although the original model contained a factor called Facilitating Condition that is related to technology infrastructure, some studies have found that the factor was particularly ineffective in some developing countries (Alasmari & Zhang, 2019). This argument might be due to the fact that generalising all technical factors and compressing them into a single factor was insufficient to describe the model's predictive power in order to assess students' perception of technology.

Therefore, in the model proposed in this study, several technical factors were added, the results of which were generally influential and had a positive impact on the students' intention. Nine technical hypotheses were tested and seven of them were established to have a positive effect on the study outcome. On the other hand, two hypotheses that did not have a positive effect were Security and Reliability of Mobile Learning on Devices and Device Processing Power. Due to the data paucity on technical factors, it is difficult to compare the present results with other studies.

This is an advantage for this proposed model, but at the same time, future studies may consider doing such comparisons.

Some studies have compared factors similar to technical factors, such as compatibility, trust, and other factors generally used in the field of technology or mobile learning. However, the studies failed to treat them as standardised technical factors to determine the intention of university students to accept mobile learning. This reinstates the importance of the results obtained by technical factors in the proposed model and their performance in the stages of analysis.

5.2.1 Device Performance

Device Performance in the measurement model was above the acceptable minimum in convergent validity and DV tests. The results of this factor in the structural model were good and remarkable. Specifically, it was the most powerful technical factor affecting students' intention to use M-learning as the p-value was less than 0.001. Therefore, if students find that their smart devices are able to perform many functions easily, their ability to use the devices in learning will increase. These findings are in line with the argument that the smartness and performance of mobile devices enhances students' performance and their ability to execute a given task (Economides & Nikolaou, 2008).

In contrast, when the performance of the devices is impaired, students are reluctant to include their smart devices in the process of gaining knowledge. The results are consistent with the general factor, Performance Expectancy, on the use of M-learning in general as both factors have the same positive impact on students' intention. The performance of the device is important as it represents the interface between the learner and the materials from which knowledge is acquired (Marguerite, 2009). Table 5.5 shows the results obtained by Device Performance in SEM tests:

Table 5.5 Device Performance Results

Measurement Model Results	***Convergent Validity***		
	Cronbach's Alpha	*Composite Reliability*	*Average Variance Extracted (AVE)*
	0.939	**0.961**	**0.892**
	Discriminant Validity		
	Cross Loadings	*Fornell-Larcker Criterion*	*HTMT*
	0.929 **0.973** **0.931**	**0.945**	**0.613**
Structural Model Results	*Path Coefficient (P-Value)*		
	0.000		
Device Performance			

5.2.2 Device Compatibility

The results showed a positive effect for Device Compatibility on students' intention as good results were obtained in both stages of SEM tests with a p-value of 0.008 (Table 5.6).

Table 5.6 Device Compatibility Results

Measurement Model Results	***Convergent Validity***		
	Cronbach's Alpha	*Composite Reliability*	*Average Variance Extracted (AVE)*
	0.865	**0.936**	**0.879**
	Discriminant Validity		
	Cross Loadings	*Fornell-Larcker Criterion*	*HTMT*
	0.920 **0.955**	**0.938**	**-**
Structural Model Results	*Path Coefficient (P-Value)*		
	0.008		
Device Compatibility			

The results revealed that students were interested in this point as an important factor in including their devices within the means they use in education. These findings are consistent with a number of studies that demonstrated the importance of compatibility (Almaiah et al., 2019) and its relevance to mobile learning. Several studies have highlighted the need to prioritise this factor since it is yet to be resolved in many technological respects (Economides & Nikolaou, 2008). Furthermore, some companies responsible for the development of mobile education continued to provide numerous services with different standards, which are not compatible (Shudong & Higgins, 2005). Hence, this affects students' acceptance of the inclusion of their devices in learning process if the educational materials are not compatible with their devices.

5.2.3 Device Connectivity

When students find that their devices' connection to the world wide web is highly efficient, their desire to use them in the curriculum is higher (Almaiah et al., 2019). This statement was confirmed by the results of this study with Device Connectivity yielding good results in both test phases (Table 5.7).

Table 5.7 Device Connectivity Results

Measurement Model Results	***Convergent Validity***		
	Cronbach's Alpha	*Composite Reliability*	*Average Variance Extracted (AVE)*
	0.766	**0.866**	**0.685**
	Discriminant Validity		
	Cross Loadings	*Fornell-Larcker Criterion*	*HTMT*
	0.908 **0.841** **0.722**	**0.827**	**0.866**
Structural Model Results	*Path Coefficient (P-Value)*		
	0.044		
Device Connectivity			

With a p-value of 0.044, the result confirmed that there was a positive effect of communication on students' intention to use mobile learning. Hence, M-learning developers should pay more attention to Data Connectivity in order to motivate students to use their devices for learning. One of the advantages of M-learning compared to the traditional ways of education is the ability to communicate from all locations. This facilitates information access to student irrespective of location and duration. However, it should be noted that there are multiple means of communication of mobile devices, such as Bluetooth and wireless network. Thus, the more powerful and performing they are, the more users are able to employ them in their way of life, including M-learning or access to information. The results of this study were consistent with Arpaci (2014), where it was demonstrated that Device Connectivity is one of the important factors affecting students' acceptance of M-learning in their school life.

5.2.4 Security and Reliability of Mobile Learning on Device

Despite the results of Security and Reliability of Mobile Learning on Devices were good in measurement model tests, the SEM (P = 0.438) revealed that the factor did not affect students' intention to use M-learning and the reliability of mobile learning on devices (Table 5.8). This does not necessarily mean that this factor is not important, but the sampled students participating in this study might not perceive the significance of the security aspect of the device, especially in the educational aspect. Users may accord more importance to the security aspect when dealing with their financial or personal data.

Table 5.8 Security and Reliability of Mobile Learning on Device Results

Measurement Model Results	***Convergent Validity***		
	Cronbach's Alpha	*Composite Reliability*	*Average Variance Extracted (AVE)*
	0.822	**0.882**	**0.653**
	Discriminant Validity		
	Cross Loadings	*Fornell-Larcker Criterion*	*HTMT*
	0.764 **0.814** **0.791** **0.860**	**0.808**	**0.707**
Structural Model Results	*Path Coefficient (P-Value)*		
	0.438		
Security and Reliability of Mobile Learning on Device			

Overall some studies have shown that the security aspect is important in M-learning. In contrast, a study on the physical aspect of mobile device use proved that the Trust factor was ineffective (Slade et al., 2015). These findings from the previous studies showed the oscillation of the security factor in different areas and study samples.

5.2.5 Device Processing Power

In this study, Device Processing Power did not affect students' intention to use M-learning despite the factor yielded good results in the measurement model (Table 5.9). Processing Power is one of the key factors that plays an important role in the convenience of mobile users (Marguerite, 2009). This result might be due to the fact that modern devices are characterised by powerful processors (Economides & Nikolaou, 2008). Nonetheless, this did not indicate that having a better processor will always translate to higher ability of the device to support the requirements of M-learning. Additionally, most mobile device manufacturers are interested in the ability of their devices to perform functions more quickly, which is consistent with their expectation of processors as seen in many hardware marketing adverts. Therefore, these combined reasons might have led to students not being interested in Device Processing Power.

Table 5.9 Device Processing Power Results

Measurement Model Results	***Convergent Validity***		
	Cronbach's Alpha	*Composite Reliability*	*Average Variance Extracted (AVE)*
	0.831	**0.887**	**0.663**
	Discriminant Validity		
	Cross Loadings	*Fornell-Larcker Criterion*	*HTMT*
	0.823 **0.846** **0.833** **0.752**	**0.814**	**0.553**
Structural Model Results	*Path Coefficient (P-Value)*		
	0.188		
Device Processing Power			

5.2.6 Device Memory Capacities

This factor also produced desired results as a good indicator in both stages of SEM tests performed in this study (Table 5.10). Device Memory is an important factor to consider when educational authorities want to incorporate M-learning into their teaching style.

Table 5.10 Device Memory Results

Measurement Model Results	***Convergent Validity***		
	Cronbach's Alpha	*Composite Reliability*	*Average Variance Extracted (AVE)*
	0.827	**0.897**	**0.745**
	Discriminant Validity		
	Cross Loadings	*Fornell-Larcker Criterion*	*HTMT*
	0.923 **0.868** **0.793**	**0.863**	**0.762**
Structural Model Results	*Path Coefficient (P-Value)*		
	0.034		
Device Memory Capacities			

This has been supported by a number of previous studies showing the importance of memory in handling different files in order to ensure a successful education (Shudong & Higgins, 2005; Marguerite, 2009; Economides & Nikolaou, 2008). The capacity to download files is reduced when the available memory is limited (Shudong & Higgins, 2005), and in turn makes it difficult for students to deal with educational materials that come in different formats of sounds, images, videos, and programmes. This was corroborated in the present study based on the positive relationship between device memory capacities and students' intention to use mobile learning.

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5.2.7 Network Coverage

Access to information of different kinds is made possible through the internet, which can be likened to the main portal for retrieving real-time information (Marguerite, 2009). As a result, internet coverage must be provided as one of the factors that facilitates learning via smart devices (Economides & Nikolaou, 2008). These opinions were confirmed by the results of this study as Network Coverage yielded positive results in both phases. In the first part (measurement model), the strength of the factor was presented, whereas the second part (SEM test) revealed the positive relationship between the factor and students' intention to use M-learning with a p-value of 0.010 (Table 5.11). This finding indicates that if students ascertain the broad availability of internet coverage in multiple places, it will increase their motivation to engage in M-learning using their smart devices.

Table 5.11 Network Coverage Results

Measurement Model Results	***Convergent Validity***		
	Cronbach's Alpha	*Composite Reliability*	*Average Variance Extracted (AVE)*
	0.688	**0.812**	**0.525**
	Discriminant Validity		
	Cross Loadings	*Fornell-Larcker Criterion*	*HTMT*
	0.702 **0.529** **0.799** **0.830**	**0.725**	**0.771**
Structural Model Results	*Path Coefficient (P-Value)*		
	0.010		
Network Coverage			

5.2.8 Network Speed

This factor is considered the strongest technical factor that has a positive influence on students' intention as the p-value obtained in the analysis was 0.001 (Table 5.12). The result showed that students expressed the importance of internet speed when dealing with educational materials. In the same vein, the findings reflect that Network Speed is a good indicator of the measurement model.

Table 5.12 Network Speed Results

Measurement Model Results	***Convergent Validity***		
	Cronbach's Alpha	*Composite Reliability*	*Average Variance Extracted (AVE)*
	0.864	**0.936**	**0.880**
	Discriminant Validity		
	Cross Loadings	*Fornell-Larcker Criterion*	*HTMT*
	0.943 ***0.933***	***0.938***	***0.846***
Structural Model Results	*Path Coefficient (P-Value)*		
	0.001		
Network Speed			

Results from this study regarding Network Speed is consistent with the reports from previous works on M-learning. For instance, Marguerite (2009) opined that the speed of data transfer may affect users' interaction, thereby resulting to obstacles in M-learning (Marguerite, 2009). Moreover, smart devices are supposed to have tools and functions that help improve internet quality and access for students to gain better learning (Economides & Nikolaou, 2008). According to Almiah et al. (2019), if students find that internet access and its benefits are constantly available, they will be encouraged to use their smart devices in the educational process. To buttress these points, Shudong and Higgins (2005) concluded that mobile devices must be compatible and support high-speed internet, so as to effectively access and retrieve the desired knowledge. Presently, several mobile devices support good networks such as 4G and 5G, which allows for faster time in downloading educational materials. Nonetheless, many students' mobiles still do not support such technologies either for financial or other reasons. The hypothesis in the model suggested in this study was supportive and demonstrated that there was a positive relationship between rapid internet access and students' acceptance of mobile learning.

5.3 Chapter Summary

The results in this study coincided with the most outcomes of various research work on general factors associated with M-learning, except for a few that were contradicting. Likewise, technical factors, which were the main aspect incorporated into the proposed model, has been discussed in relation to previous studies. Interestingly, the findings were similar with the proposed model demonstrating its suitability in identifying the factors influencing students' intention to use M-learning. Overall, the results of the study highlighted the importance of technical factors and their impact on students' acceptance of mobile learning.

CHAPTER 6

CONCLUSION

6.1 Introduction

This chapter discusses the objectives set by the researcher at the beginning as guided beacons in the study of the impact of technical factors on The University of Hail students' intention to accept mobile learning. Several scientific methods were employed for the research objectives to be achieved. This chapter also reviews the contributions of the proposed model to the body of knowledge through numerous contributions that illuminate the strategies that could be adopted by scientific institutions and universities to attain the best implementation of mobile learning. Furthermore, this chapter highlights the importance of this study and the benefits to many authorities, whether educational or non-educational corporations. Lastly, the limitations and recommended future studies are discussed.

6.2 Recapitulation of the Thesis Objectives

This study initially set a number of objectives that determined the theoretical and practical frame to be followed. This research began with the achievement of objectives before proceeding to several steps and arrangements highlighting the results of this research.

6.2.1 *Objective 1*: To primarily identify technical factors that influence students' acceptance of technology in M-learning

The first objective in this study was to identify the factors influencing students' acceptance of M-learning. Hence, various scientific methods were employed to answer the research question. Systematic literature review was conducted on the application of technology in education. This entailed the various developmental stages of educational methods until the recent era. Thereafter, the concept of M-learning was introduced and the most influential factors in SLR (Appendix H). In the beginning, technology was simple, innovative and sparingly used in the educational process. The teacher was still the focus of the teaching process and the main factor in which the student received information from. Thereafter, some educational institutions began to introduce new form of education, which contained technological component which was then regarded as e-learning. The methods used in this type of education varied in many forms and sources, where a number of technological tools that were available at the time, such as computers, CDs, video files, and audios were employed in the explanation of the teaching materials.

Although all these methods addressed deficiencies in the educational process and increased students' assimilation of information, they were considered to be secondary factors rather than essential to education. As long as the teacher uses it whenever he wants, at the same time, he is still the basis of the educational process. With the development of communications and the emergence of new generations of technological devices, the focus for their inclusion in education has continued to increase in recent times. This has been buttressed with the emergence of technology-based educational materials. Subsequently, the latest development is known as M-learning through which students can acquire knowledge and study via their mobile devices.

These smart devices are not only a means of communication or entertainment, but also one of the factors that a student can use as a partial substitute of the teacher. However, several factors ranging from technical to non-technical aspects have been reported to influence students' use of M-learning and their acceptance as presented in Chapter Two of this thesis. These factors need to be considered when developing strategies for students to transit from traditional form of education to M-learning, which entails the use of their mobile devices for learning purposes.

As an answer to the first research question as well, previous studies have focused on the factors associated with students' intention to use M-learning and included it in their learning career. These factors varied between general factors applicable to all areas and those specific to some fields. To measure the acceptance of technology among students, many acceptance models have emerged over the years. The most famous of these models was the UTAUT and TAM, which were employed by researchers to investigate the intention of acceptance among students. These two models were used by adding various factors and extended multiple times in previous studies. Based on the reviews of existing literature, factors such as trust, quality, and facilitating conditions have excelled in some areas.

Other general factors also play a role in the acceptance of mobile learning, as evidenced by studies in the second part of this study. Technical factors have not received much attention in previous studies as a review of several papers in this area revealed a lack of knowledge in the extent to which technical factors affect students' intention to accept mobile learning. This was particularly evident, especially in some developing countries and Arab countries. This study focused on determining the impact of technology in general by including some previous studies and extensions of the acceptance models. This was carried out by using either one factor that includes the technique as the original model on which this study was based, so that technical factors were limited to the facilitating conditions.

Although some studies included technical factors, it was not considered as the main focus and no study assessed their potential role as influential factors of mobile learning acceptance. This study showed that technical issues affect the use of mobile devices and applying them educational fields. Also, the present study revealed that these phenomena varied between communication factors, security aspects and other factors. Hence, a number of technical factors were identified that are likely to influence students' intention to accept M-learning and they were incorporated as an extension to the original UTAUT model which outperform previous acceptance models. The factors considered in this study were Device Performance, Device Compatibility, Device Connectivity, Security and Reliability of Learning on Device, Device Processing Power, Device Memory Capacities, Network Coverage, and Network Speed.

6.2.2 *Objective 2*: To develop a model to measure the acceptance of students toward M-learning from Technical Factors' aspects.

In order to fulfil the second research question, this study developed a UTAUT-based model that includes two parts. The first section comprised general factors that have been studied in advance by the original developer of the model and a large number of researchers. The second section contains the technical factors identified in this study, which are yet to be explored in relation to students' intention to accept M-learning. A number of hypotheses were developed to measure the impact of general and technical factors on the students' intention of using their devices as a learning tool. The model was built through the use of SmartPLS by installing the tools provided by the software to develop hypotheses related to intention.

The research instrument, which was a questionnaire, was then built and distributed to the students of Hail University. The questionnaire was validated for use in several ways, including presenting it to a number of experts and conducting CVI tests, as well as other scientific techniques to translate the texts contained in the instrument for the participants' ease of understanding. Several methods were used for data collection and analysis and applied in the construction of the proposed model in this study.

6.2.3 *Objective 3*: To evaluate the developed model of acceptance of M-learning and produce a guidelines diagram based on the proposed model.

In order to achieve scientific criteria to verify the results, the data was analysed using several well-established scientific tools to ensure the validity and effectiveness of the model. Likewise, numerous were employed to determine the level of reliability given by the factors to its elements. The results were validated using SEM tests, which was divided into two parts. The first part checked the validity and reliability of the measurement model, whereas the second aspect verified the structural model. Both methods are among the scientific tools that have been established to be effective for model verification and powerful in predicting students' intention to use technology. These procedures were explained in detail in Chapter Three of this thesis and they were employed to determine the effectiveness and validity of the proposed model. Furthermore, the predictability of the proposed model in assessing the impact of technical factors on students' intention to use mobile learning was ascertained. All these results assisted in building a guidelines diagram, that was verified by experts for the successful application of M-learning in universities or other educational institutions. Additional information about the guidelines is presented in the contribution section.

6.3 Contributions of the Research

In general, this research through the form submitted, has contributed by establishing an extended model that leads to a better understanding of the students' intention towards using M-learning technology. A systematic literature review was conducted to provide tenable answers to questions about mobile technology and acceptance models (Alghazi et al., 2020). The findings contribute to the body of knowledge regarding students' needs and factors affecting their use of the technology. Moreover, better understanding of the underlying factors and events will also assist various educational institutions and software developers to take the advantage of such knowledge in educational environments. Hence, they can consider the factors when developing any application based on the M-learning and involving it in education.

6.3.1 Identification of Technical Factors Affecting M-learning among Hail University Students

This research has identified the current shortcomings of M-learning. Studies have shown that there are many challenges in the usage of mobile devices for learning purposes. Since the advent of the technology age, it has offered numerous advantages and benefits to human life. However, the use of the technology remains incomplete due to the challenges faced by users in the process of applying mobile education. Therefore, through research and scrutiny of many published papers, this study sought to identify factors affecting students' involvement in M-learning. By reviewing both original and review articles, the factors influencing the implementation and use of M-learning were identified.

In addition, this study has shown that there are many deficiencies in the use of technology, especially in developing countries. In other words, the study revealed that Arab countries continue to suffer from data paucity on M-learning and the impacts of technology. These findings reflect the limited research on students' intention to use mobile technology for learning purpose. Likewise, the literature review showed that there knowledge scarcity on the factors influencing the acceptance of M-learning in Saudi Arabia. Therefore, this study is the first attempt to identify the technical factors contributing to students' intentions to use M-learning. Also, the results reflect the need for technical factors to be further investigated in Saudi Arabia and other Arab countries.

The study determined the reason behind the chosen sample research at The University of Hail as it is considered as one of the modern universities and distinguished by the presence of a deanship on e-learning since its inception. These points make it a good environment for the application of M-learning after identifying the factors that affect the acceptance among its university students. Based on the above, this study identified the technical factors as a requirement to build a number of hypotheses to assess their impact on students' intention to accept mobile learning.

6.3.2 Extended Model of Acceptance of Mobile Learning

After identifying the technical factors that had not been investigated in previous studies, a model containing these factors was built. It was tested to assess how strong the model will predict Hail University students' intention to accept mobile learning. The proposed model in this research was based on the UTAUT model, which has been established in previous studies to outperform other models. Furthermore, UTAUT model is the most recent compared to the previous popular models such as TAM and it is one of the most cited in many studies. The proposed model was divided into two sections; the first contains the general factors already studied to ensure its validity and effectiveness on students of University of Hail, while the second aspect was the technical factors. These two perspectives were considered to build a model that measures students' intention to accept mobile learning in order to compensate for the deficiency in the previous models.

Moreover, this study involved enriching knowledge and delivering more useful sciences into the field of mobile learning through the results of the proposed model. It showed that most of the technical factors presented in this study had a positive influence on students' intention to use their mobile devices as learning tools. Thus, researchers in this field can take advantage of this model and disseminate it to other settings, whether in universities, institutes, or educational corporations.

6.3.3 Guidelines to Help Higher Education Authorities to Apply Mobile Learning Successfully

Guidelines and instructions are needed for M-learning to be professionally applied and implemented successfully as a novel teaching method for students. In the proposed model, this study assumed two aspects influencing students' intention to accept mobile learning: general and technical factors. General factors have been extensively studied in previous research; hence, their relevance to M-learning is already known. This study reinstated the role of general factors in predicting students' intentions to use M-learning, except the social factor that was not significantly associated with the outcome. However, this research focused on technical factors and how they may serve as prerequisites before implementing mobile learning. Amongst the eight technical factors developed in this study, six of them in producing a positive effect in the proposed model.

These findings requires educational institutions and academics to abide by certain instructions and guidelines mobile learning to be successfully implemented. This could be achieved by following the guideline diagram (Figure 6.1) produced based on the results of the proposed model. Moreover, the diagram was assessed and validated by experts, therefore, affirming its suitability for educational institutions or universities intending to implement M-learning.

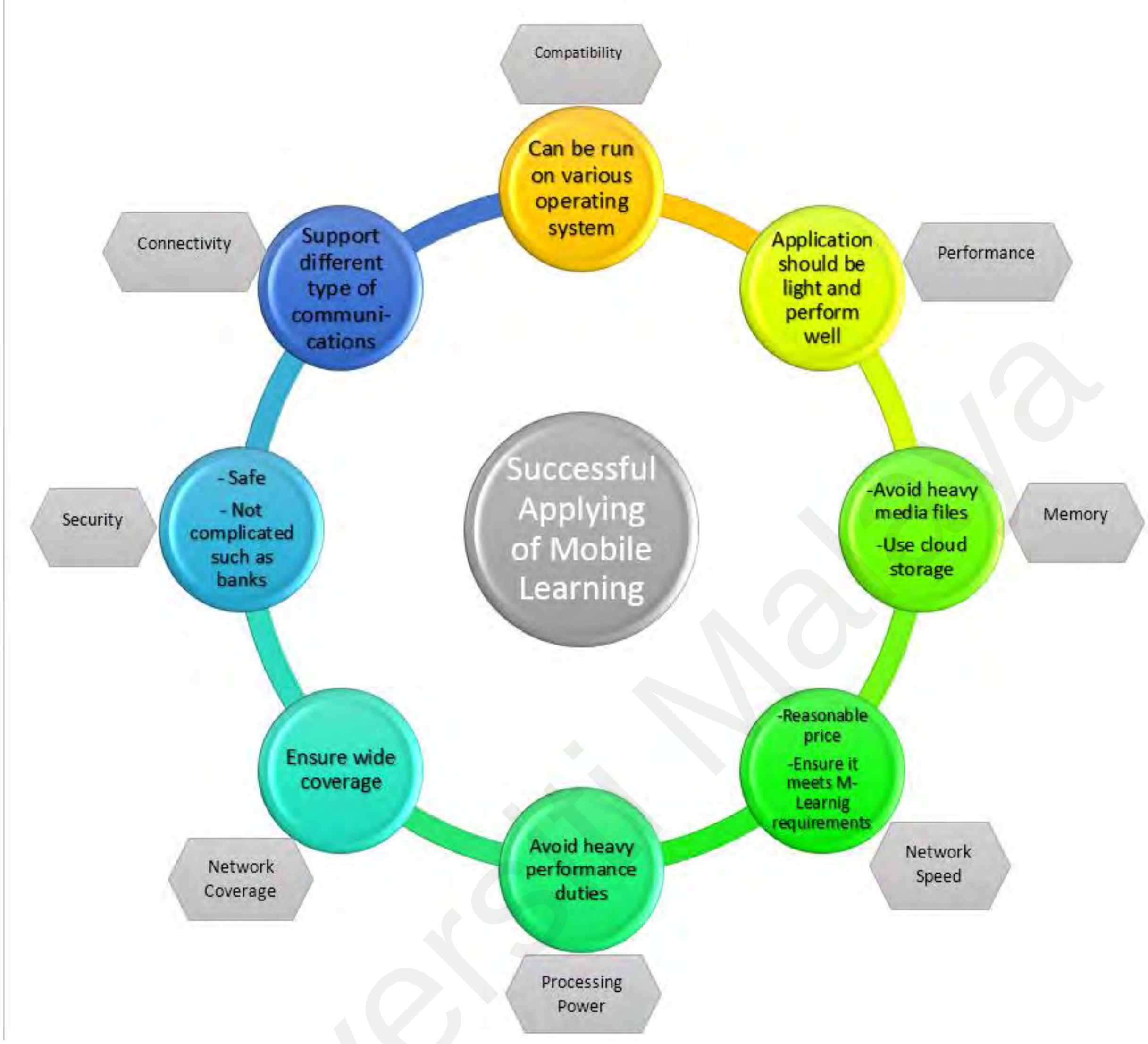

Figure 6.1 Guidelines Diagram

- Device compatibility: It is essential that universities and educational institutions ensure that student-owned devices are compatible with mobile learning applications. Many students have different types of mobile devices such as PAD's and phone with diverse operating systems (i.e., iOS, Android and so on). As a result, students should find programmes and applications through which they learnt are operable in all devices of any kind. This requires a greater effort from developers of educational programmes and applications to pay attention to compatibility between devices to encourage students to seek knowledge through their own devices.

- Device connectivity: Mobile devices are commonly designed with several communication technologies, such as Bluetooth and Wireless. Students need to communicate and interact with each other. This should be considered when developing M-learning applications so as to gain more attention in terms of support. Students will be encouraged to use their mobile devices when there are multiple ways of communication, irrespective of whether it is for educational or non-education purposes. For instance, it was recently that some mobile devices were upgraded to use simple technologies such as Bluetooth. Hence, when designing educational applications, this has to be taken into account by including multiple means of communication and interaction. This will definitely enhance the utilisation of mobile devices for learning purposes.

- Device Performance: If students find that his device supports the completion of a large number of functions easily and smoothly, it will motivate them to rely on their devices in gaining knowledge. As a result, if educational applications and programmes used in education are light and perform effectively, it will facilitate the success of mobile learning.

- Device Memory: Since the inclusion of e-learning in the past decades, many educational electronic means such as videos and photos have emerged. These methods were at the beginning of technology in small sizes that might not exceed ten megabytes. However, with developments in the modern era, the sizes of these materials have increased to become a burden on some devices. This is reflected among users as they have to delete several applications and other files in order to relieve loads on the device memory. These flaws need to be considered by developers of educational programmes. First, educational applications do not contain heavy multi-files and media of very large sizes that affect device memory. Instead, new storage technologies such as cloud computing should be employed. Second, some targeted devices for mobile learning application have expandable memory capacities; however, some mobile devices come with no expandable memory.

- Network Coverage: An important factor for the optimal application of M-learning is for the student to be able to use the internet to access educational materials anywhere. Any event that restricts internet access will ultimately affects the successful implementation of M-learning. Universities and educational institutions must ensure that the network is properly covered before this type of education is implemented.

- Network Speed: In this study, this factor demonstrated a strong positive effect on students' intentions to use their mobile devices for learning purpose. This indicated that students prioritise the speed of internet access and download provided by the suppliers of these services. The world is now living in an age of speed which requires developers to work harder to meet these growing needs as the rapid transmission of information helps to speed up its spread. Currently, the implementation and use of many technologies requires high communication speed, such as live video conferencing and virtual classes used by teachers and students. In addition, there are numerous educational materials that require high sound and images resolution. High performance is another important criterion for the implementation of certain educational materials, thereby necessitating larger size and network speed to be able to meet the requirements of such files.

Two factors, Security and Devices Processing Power, did not have a positive impact on students' intentions to use mobile learning. This does not necessarily mean that they are not important, but at the same time, institutions and educational providers that develop M-learning should may not need to emphasise the steps taken in this area. For example, when using educational applications, a student does not want to require many complications, such as those used in banks and financial organisations. Similarly, these applications do not require processors with large, high-performance specifications that may lead to higher prices for these devices.

6.4 Significance of the Research

The importance of this research relies in the development of specially oriented model to measure student acceptance of learning process provided through the use of mobile phones. Subsequently, this will assists educational institutes or other organisations that want to take advantage of and adopt M-learning. The proposed model benefits software developers through enriching their knowledge to consider the factors influencing students' or learners' acceptance of mobile education when developing M-learning applications. In a similar manner, this research will benefit companies, individuals, and educational institutions that wish to apply M-learning in their affiliates.

Based on the results of this study, software developers can ascertain the factors of interest among students that should be focused on, such as mobile memory and compatibility between devices. Likewise, the results of the proposed model showed that some factors are not of great importance to students, such as security and the type of processing powers used. The aggregation of these findings broadens the understanding of developers of educational programmes and give them a better view of what students want from their devices when used in education. Furthermore, this study is a focal point for legislators at universities and other educational institutions to provide a good learning environment based on M-learning without any obstacles or problems that students may face when applying this type of education.

Accordingly, this research contributes to the body of knowledge in this field by establishing an extended model that leads to acquiring a better understanding on students' intention towards applying M-learning. As such, this study will also provide further insights into the need for M-learning in the educational context and the factors affecting the use of this technology. This understanding will also lead to various educational institutions and software developers to take advantage of the knowledge regarding the needs of students and the factors affecting such technology being employed in educational environments and to be considered when developing applications based on the principle of M-learning.

6.5 Limitations

Several attempts have been made to investigate the factors affecting students' acceptance of mobile learning, but none focused on the impact of technical factors on mobile education, especially in Arab or developing countries. Notwithstanding the acceptable results observed in this study in terms of technical factors, there are still limitations in some aspects. For instance, all technical factors were not covered in this research.

There are diverse techniques to be considered by administrators in the process of guiding students to use their mobile devices for learning purpose. Hence, this study was not able to cover all the existing techniques because they are time-consuming and requires extensive efforts to dwell on them. Therefore, researchers may consider some technical factors that were not included in this research, when investigating to their impact on students' intentions. In addition, this study showed that a number of technical factors have an important influence on students' intentions to use mobile learning, but there are still some aspects that need to be explained further. These aspects include social factors and the security aspects of mobile devices and processors contained in smart devices, which were not statistically significant. These factors need to be further studied and scrutinised so that it is possible to determine whether the weak influence is true or whether the results were due to study location. It is also worth noting that the study participants are students of the University of Hail, whose data was collected regardless of the difference in the level of experience, courses specifications and the type of devices used.

Another limitation is the study location, which was the University of Hail in Kingdom of Saudi Arabia, indicating that all the participants were from a single institution. This reduced the strengths of generalising the results to an external population of students. Nevertheless, this limitation could be considered in future research by applying the proposed model to other samples elsewhere so as to broaden the present knowledge on the impact of technical factors on individuals' intention to use M-learning.

6.6 Future Work

This study covered several technical aspects that have been established to impact students' intention to use mobile devices in the educational process. However, some aspects require further studies, such as the screen size, i.e., the extent to which the display is integrated with different devices and the multiplicity of types. In addition, researchers are recommended to conduct further studies on the impact of batteries available in students' smart devices on their desire to use mobile learning. Furthermore, the effectiveness of battery capacity should be studied. This is because it has been established that as the load on the mobile phone increases, the same applies to its battery consumption, which often leads to its rapid depletion. These events may result in students being discarded from using their mobile phones to learn. Moreover, future researchers are encouraged to share all important findings irrespective of the statistical significance. Likewise, the proposed model in this study could be applied elsewhere to expand the results. Finally, this study was conducted in a limited place, therefore, future studies should take this into account and diversify study samples on a wider geographical scale.

6.7 Conclusion

This chapter discusses the objectives of this study, which is the bridge the knowledge gap regarding the impact of technical factors on the intention of students studying at Hail University to accept mobile learning. The study achieved all the objectives set by the proposed model which demonstrated its strength and predictive ability to measure the student acceptance. This chapter also highlighted the contributions of the proposed model to the body of science which will benefit education authorities in identifying the technical factors affecting the implementation of mobile learning. This study proposed a number of guidelines and instructions for developers, universities, and educational institutions to enable a high-quality mobile learning implementation. The limitations of this study were well-acknowledged and recommendations for future research were also outlined.

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