Evaluating the Success of E-learning Systems -

The Case of Moodle LMS at the University of Warwick

By

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A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Computer Science

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DEDICATION

I owe everything to my parents and husband, who encouraged and helped me at every stage of my personal and academic life and longed to see this achievement come true. I dedicate this work to **my parents** and my loving husband **Dr. Fadel Abu Sini,** and my adorable kids **Rital** and **Yousef**. Every breath of my life is dedicated to you. I love you all.

DECLARATION

This thesis is submitted to the University of Warwick in support of my application for the degree of Doctor of Philosophy. I hereby declare that, except where acknowledged, the work in this thesis has been composed by myself and has not been submitted elsewhere for the purpose of obtaining an academic degree.

Dimah Al-Fraihat

Signature: ____________________________

Date: _______________________________

PUBLICATIONS

Below are the publications distilled from this PhD research:

1. Al-Fraihat, D., Joy, M., & Sinclair, J. (2017). Identifying Success Factors for e-Learning in Higher Education. In ICEL 2017-Proceedings of the 12th International Conference on e-Learning (p. 247). Academic Conferences and Publishing Limited.
2. Al-Fraihat, D., Joy, M., & Sinclair, J. (2018). A Comprehensive Model for Evaluating E-learning Systems Success. Distance Learning Journal. Information Age Publishing IAP, Volume 15 Issue 3.
3. Al-Fraihat, D., Joy, M., & Sinclair, J. Investigation of University Students Experience in the Design and Use of Moodle LMS. Paper submitted to E-learning and Digital Media (under review).
4. Al-Fraihat, D., Joy, M., Masa'deh, R., & Sinclair, J. (under review). Evaluating E-learning Systems Success: An Empirical Study. Paper submitted to 'Computers in Human Behavior'.

ABSTRACT

E-learning is a direct result of the integration of education and technology, and is increasingly considered as a powerful medium for learning. The undeniable significance of e-learning in education has led to a large growth of e-learning courses and systems offering different types of service. Thus, evaluation of e-learning systems is vital in ensuring successful delivery, effective use, and positive impact on learners. In recent studies, the vast majority of universities report having adopted varieties of e-learning systems and platforms to facilitate the students' learning process. However, while adopting e-learning systems is useful, it is not an end in itself. In reviewing the literature, studies have revealed many problems with these systems, such as meeting users' requirements and the suitability of these systems for targeted users. In order to improve the current systems to satisfy users' needs, it is important to understand the different aspects that influence the quality and success of these systems. Hence, a new model for evaluating the success of e-learning systems is introduced in this research.

Based on an intensive review of the literature, four approaches were identified and analysed as a theoretical basis for the research: DeLone and McLean's information systems success model; the Technology Acceptance Model; the User Satisfaction Models; and the E-learning Quality Models. In order to provide a general comprehensive definition of e-learning success measurements, the four approaches found in the literature were considered in developing our model. The proposed model includes eleven constructs: technical system quality; information quality; service quality; educational system quality; support system quality; learner quality; instructor quality; perceived satisfaction; perceived usefulness; system use; and benefits. The model is comprehensive, and not based on the number of constructs, but on the intention to provide a holistic picture and different levels of success related to a broad range of success determinants, rather than focusing on a specific construct. As such, it forms an original contribution to knowledge.

To test the model, an empirical study was conducted. First, an instrument was designed to assess the perceptions of students towards e-learning system success. Second, an expert study with 30 e-learning experts was carried out to confirm the measurements and indicators. The model was then tested in the context of the University of Warwick by fitting the model to data collected from 563 students engaged with an e-learning system. Both quantitative and qualitative data were analysed. The results confirm that the model proposed in this study is valid and reliable. Thus, the study contributes to the growing body of knowledge with a valid and reliable model and an instrument to evaluate e-learning systems success (EESS model). Further, the study sheds light on important issues and recommendations that should be taken into consideration to improve the perceptions of satisfaction, usefulness, use, and benefits of the e-learning systems. The study further provides practitioners with several practical contributions.

CHAPTER ONE: INTRODUCTION

1.1 Chapter Introduction

This chapter identifies the research context, and provides a research overview, a statement of the research problem, the motivation for conducting this research, the research questions and objectives, the research process, and an outline of the thesis.

1.2 Research Context

This research lies in the field of Computer Information Technology with a focus on information systems, particularly e-learning systems, and as such, contributes to theory building (March & Smith, 1995). The research aims to find out the factors that influence the success of e-learning systems. It proposes a model and empirically examines its applicability and validity. This research identifies the success factors upon which universities and higher education institutes can evaluate their e-learning and learning management systems.

1.3 Research Overview

The development of Information Technology (IT) has led to improvements in various fields, such as finance, business, health, and education. As a result, education has grown rapidly and stimulated the adoption of e-learning. E-learning is directly resulted from the integration of education and technology and is increasingly considered as a powerful medium for learning. In addition, it has facilitated learning by delivering a learner-centred and interactive learning environment to anyone, anywhere, and anytime (Khan, 2005). Moreover, it plays a significant role in shifting from teacher-centred to student-centred education (Taha, 2014).

From its origins, e-learning has inevitably become mainstream in the education sector and has been very widely adopted in higher education. According to Dahlstorm et al. (2014), 99% of institutions have Learning Management Systems (LMSs) in place, and 85% of them have been utilized. In the UK, 95% of higher education institutes have adopted LMSs to support their educational services (McGill and Klobas, 2009).

Accordingly, the quality of e-learning systems has received a considerable amount of attention and a large number of researchers have attempted to identify e-learning success factors to maximize the effectiveness of these systems. The majority of these studies have examined the key determinants of e-learning systems success, ignoring the synergistic effects of the success variables interacting together (Eom and Ashill, 2018). Other directions of research have dealt with the direct relationships between e-learning quality factors and usage or satisfaction.

A significant amount of research in e-learning has advanced our understanding of the pivotal success factors of e-learning. However, we believe that the excessive amount of measurements among dependent and independent variables is the main challenge that researchers face in developing an e-learning success model. Evidently, there is a need for a comprehensive success model for multiple levels of success (Eom and Ashill, 2018). Bearing in mind that an e-learning system is an information system that integrates human entities (i.e., learners, instructors) and non-human entities (e.g. learning management systems), it is crucial to investigate multiple dimensions of success in relation to both entities.

1.4 Research Problem

The undeniable significance of e-learning in education has led to a massive growth of e-learning courses and systems offering different types of services. The global e-learning market is expecting the spending on e-learning market to reach $325 billion by 2025 (GEM website[1]). Unfortunately, e-learning projects sometimes fail to achieve their goals and face slow progress and increasing dropout rates (Liaw, 2008; Frimpon, 2012). The lack of evaluation of success measurements remains a top concern for both practitioners and researchers (Urbach et al., 2008) and is believed to be a significant reason for e-learning systems failure (Al-Sabawy, 2013). Further research is needed to gain a better understanding of the factors impacting the success of e-learning systems and to overcome the challenges that may prevent e-learning systems from achieving their goals.

Cidral et al. (2018) classified studies in e-learning from 2001 till 2016. It was found that studies started with a focus on intention to use, adoption, usability, course contents and customization from 2001 and evolved later to include satisfaction from 2007. Recently, from 2013 to 2016, studies have focused on "the overall success of e-learning and on how students' characteristics affect e-learning" (Cidral et al., 2018). In general, earlier studies have been concerned more on technology itself. However, as technology has become increasingly reliable and accessible, recent research has focused more on students' and instructors' attitudes and interaction, which play a vital role in e-learning success (Liaw et al., 2007; Selim, 2007; Cheng, 2011). Further research is needed to evaluate these systems

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[1] Global E-learning Market website, accessed July 3, 2018 from www.reuters.com/brandfeatures

for continuous improvement of e-learning systems and to ensure that the outputs meet users' needs (Al-Sabawy, 2013).

Another issue regarding developing an e-learning model is the selection of factors to measure the success of e-learning systems. Researchers agree that further studies are needed to better understand the overall view of e-learning success. Most of the previous research dealing with the e-learning systems' success issue has been limited to one aspect, and more specifically, user satisfaction (Ehlers and Hilera, 2012).

Accordingly, the current research addresses the following problems related to the evaluation of the success of e-learning systems:

- There is a lack of recent e-learning evaluation studies that incorporate the different aspects of success in one complete model (Ehlers and Hilera, 2012);
- There is a lack of research that focuses on the students' and instructors' factors in the success of e-learning systems (Cheng, 2011; Cidral et al., 2018);
- There is a need for further research and investigation of e-learning quality factors to increase the explanatory power of existing models that address the success of e-learning systems (Van Cauter et al., 2017).

Consequently, there is a strong need to establish a model that can be used for evaluating e-learning systems success and ensuring that the different aspects are considered. This study aims to fill this void and address these problems by investigating the factors that influence the success of e-learning, and proposes a model that incorporates the determinants and aspects of e-learning success that are of recent concern and interest to e-learning users.

As a result, this study provides major contributions to theoretical research in the information systems field, in the context of e-learning, and shares practical experiences of e-learning success measurements in developed countries, such as the UK, in which technology is used to enhance learning, flexibility, communicating and entertainment (Naresh and Reddy, 2015).

1.5 Research Motivation

Motivated by the call for further development and validation of DeLone and McLean's (2003) model for evaluating the success of information systems, this research has been conducted to gain a better understanding of the determinants of success of e-learning systems, extending the original model in the context of e-learning, and empirically testing it in the UK context.

Another motivation for this study is related to the advantages that can be obtained from the findings of this study, which may be shared with practitioners. This research provides insights that enable higher education institutions to strengthen their e-learning outcomes and further improve them by highlighting the determinants of user satisfaction, use, usefulness, and benefits of e-learning. This research is empirically conducted by collecting data from students at the University of Warwick, from different levels and fields of study, who use the Moodle LMS as an e-learning system to facilitate their learning. Obtaining results from students using the Moodle LMS can be useful to propose recommendations to practitioners and senior managers of e-learning systems in higher educational institutions, in general, and to the University of Warwick, in particular, to enhance the performance of these systems, and to solve any problems they present.

1.6 Research Questions and Objectives

The significance of this study arises from the earlier absence of studies that involve different e-learning determinants in the evaluation of e-learning system success. Given this context, the research aims to answer the following research questions.

RQ1: What are the factors that influence the success of e-learning systems?

RQ2: What are the determinants of perceived satisfaction, perceived usefulness, system use, and benefits of e-learning systems from students' perspective?

RQ3: Is the model of the study valid and reliable for the evaluation of e-learning systems?

To address the research problem, and to answer the research questions, the following are the objectives that need to be met.

OB1: To thoroughly investigate and analyse the literature and explore the dimensions and factors that influence e-learning systems success.

This objective is the foundation step in this research, and involves studying the literature in depth to identify the themes and sub-themes for the success and quality of e-learning and information systems to build the initial conceptual model.

OB2: To establish the model and identify the relationships among the constructs of the model supported by the literature.

This objective is concerned with developing the model of the study. The initial model has been developed to comprise the constructs, factors, and relationships between the constructs. The relationships within the model are hypothesised based on related studies and theoretical justifications from the literature.

OB3: To test the reliability and validity of the developed model.

This objective is concerned with empirically examining the model by collecting quantitative and qualitative data relating to students' experience in using an e-learning system. This objective is multifaceted and conducted in three stages to test the model.

OB3.1 To test the measurement model (outer model)

This objective is concerned with testing the reliability and validity of the indicators and constructs of the model.

OB3.2: To test the structural model (inner model).

This objective is concerned with examining the potential of the relationships among the constructs and investigating the formulated hypotheses.

OB3.3: To explore students' opinions about the factors that influence the success of e-learning systems.

This objective revolves around analysing qualitative data from students to elicit e-learning success factors from students' perspective.

OB4: To test the performance of the whole model to determine its suitability and applicability for the evaluation of e-learning system success.

The focus of this objective is to explore the model performance in terms of explained variance, predictive relevance, and to assess the whole model fit.

1.7 Research Design and Process

The research design is an overall research procedure which consists of a series of techniques and steps to carry out the project, from start to finish, leading to successful completion of the research objectives and an addressing of the research questions (Creswell, 2009). The activities conducted in this research include a definition of the research problem, research questions and objectives (Chapter 1); the literature review of information systems and e-learning systems models and theories (Chapter 2). After achieving a complete view based on the literature review, the second step is to develop the research model (Chapter 3). This is followed by the methodology to present the methods, issues, procedures and techniques to test the developed model (Chapter 4). Chapter 5 presents the preliminary data analysis. Chapter 6 presents the model testing results, which includes the analysis of quantitative and qualitative data. Chapter 7 discusses the results obtained from testing the model. Finally, Chapter 8 presents the conclusion, the research contributions, limitations, and recommendations for future research. The following flow chart (Figure 1.1) presents the key activities undertaken within this research.

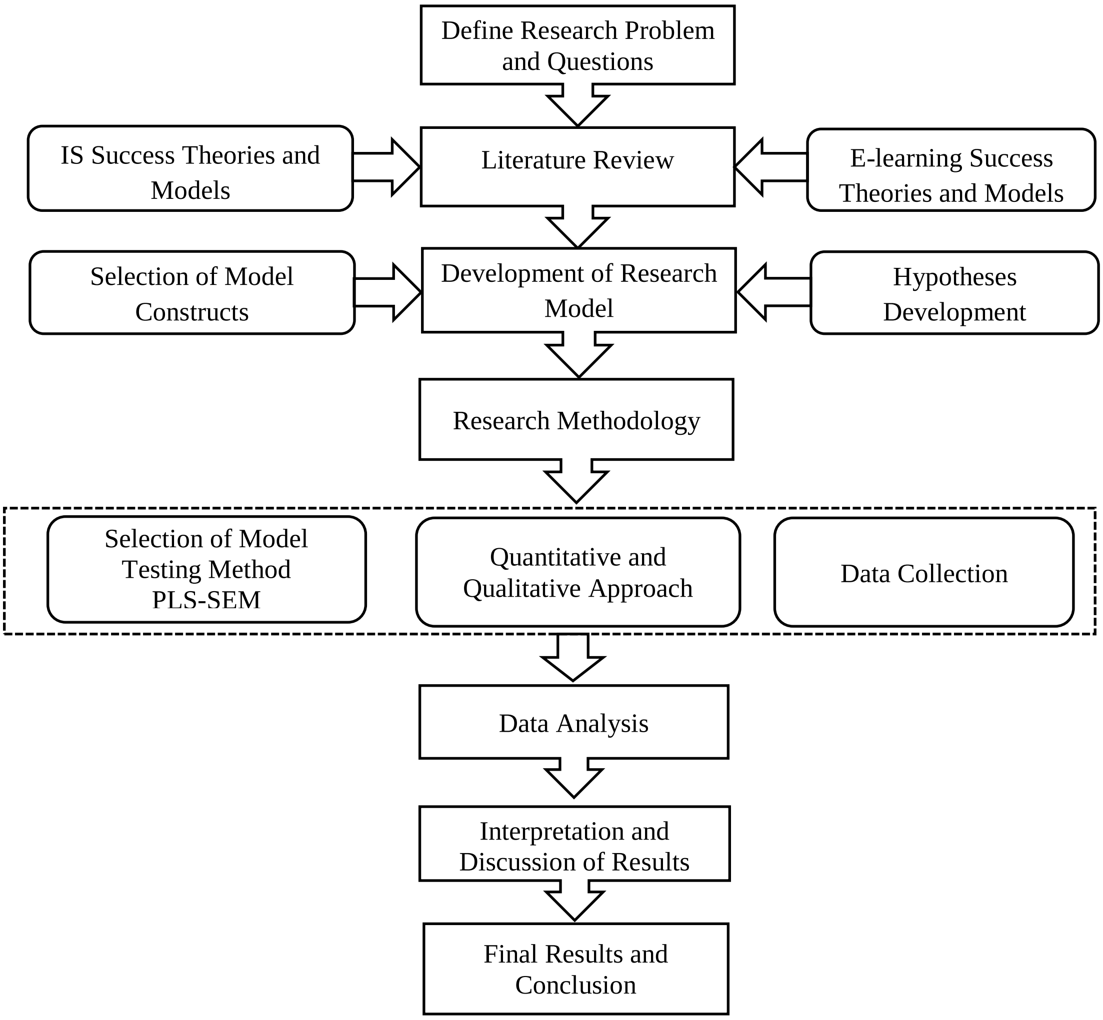


Figure 1.1: Research Design and Process in this Research

1.8 Thesis Outline

This thesis is structured in eight chapters as follows:

Chapter 1: INTRODUCTION

- This chapter provides research context, research overview, research problem, motivation, research questions and objectives, and research process.

Chapter 2: LITERATURE REVIEW

- This chapter reviews the state-of-the-art literature in the field of e-learning and information systems success factors, models, theories, approaches, and determinants.

Chapter 3: MODEL DEVELOPMENT

- This chapter proposes the model of the study to evaluate the success of e-learning systems. This chapter describes the constructs of the model and explores studies that assist in selecting the constructs of the model. This chapter also outlines the formulation of the study hypotheses based on the relations posited among the constructs of the model and the justification for proposing them.

Chapter 4: RESEARCH METHODOLOGY

- This chapter introduces the methodology adopted to test the model of the study, a discussion of the other methodological procedures and the available strategies and the justification for adopting our research method. It also includes the sample of the research and the rationale for using this sample. The technique used for data collection and analysis is presented in this chapter.

Chapter 5: PRELIMINARY DATA ANALYSIS

- This chapter presents the analysis of the data collected from the study sample. The first part shows the procedures followed to prepare the data. The second part illustrates the demographic information of the sample. The descriptive analysis for each construct in the model is presented in the third part.

Chapter 6: MODEL TESTING

- This chapter presents the model's testing methodology and the results obtained. The methodology to test the measurement and structural model using PLS-SEM is presented in the first two sections followed by the methodology for content analysis. Results of testing the two models are presented. The results of testing the hypotheses are reported. The last part is allocated to the results of the content analysis of students' comments.

Chapter 7: DISCUSSION OF RESULTS

- This chapter discusses the findings of the measurement and structural model results and discusses the content analysis results. The performance of the model is also discussed in this chapter.

Chapter 8: CONCLUSION & RECOMMENDATIONS

- Research findings are summarized in this chapter by demonstrating how the research objectives have been met. In addition, this chapter includes the research contribution, recommendations, limitations, and future directions.

CHAPTER TWO: LITERATURE REVIEW

2.1 Chapter Introduction

Reviewing the literature is the first step in this research. The literature review serves as a basic phase for this research to explore the models, theories, and approaches that is concerned with evaluating e-learning systems success. The themes and sub-themes adopted to develop the study model are mainly elicited from the literature. However, this research is multidisciplinary, so there is a wide range of literature that deals with the success of e-learning systems. Considering the fact that e-learning systems are special types of information systems, e-learning success models are inevitably inherited from the success models and theories of information systems. An intensive review of the literature has revealed four categories of models and theories for measuring the success of e-learning: the DeLone and McLean information systems success model (D&M model); the Technology Acceptance Model (TAM); the User Satisfaction Models; and E-learning Quality Models (Al-Fraihat et al., 2018). To organize the literature effectively, this chapter starts with e-learning definitions, systems, and platforms followed by the scope of the literature review. The literature relating to the four approaches is then discussed in four sections, one for each approach.

2.2 E-learning Definition and Related Concepts

2.2.1 E-learning Definition

E-learning has expanded rapidly on account of the variety of technologies and devices available to access learning resources, such as laptops, computers, smartphones, and tablets. It has facilitated learning by delivering a learner-centred and interactive learning environment to anyone, anywhere, and anytime (Khan, 2005). In addition, it plays a significant role in shifting from a teacher-centred to a student-centred education (Taha, 2014).

Due to technology continuously evolving, there is no single consensual definition for e-learning. For example, Lee et al. (2011) defined e-learning as “an information system that can integrate a wide variety of instructional material (via audio, video, and text mediums) conveyed through e-mail, live chat sessions, online discussions, forums, quizzes, and assignments”. Other researchers use the concept of e-learning to refer to the technology intervention in the learning process (e.g., Sun et al., 2008). However, technology is a general term, and several concepts have emerged under technology, such as technology enhanced learning (TEL); computer assisted learning (CAL); artificial learning environment (ALE);

mobile learning (m-learning); web-based learning; Internet-based learning; and electronic learning (e-learning).

Other definitions for e-learning have emanated from the strategy of delivering this type of learning, for example, online learning, offline learning, blended learning, and distance learning. Other definitions are based on the interaction type, for example, synchronous learning or asynchronous learning.

Further, e-learning is used to refer to the platform used to launch the content, for instance, learning management systems (LMS), content management systems (CMS), massive open online courses (MOOC), connective massive open online courses (c-MOOC), little open online courses (LOOC).

Moreover, the concept of e-learning has been used to focus on the independency of learning, such as self-paced online learning, self-directed learning (SDL), self-regulatory efficacy, and self-regulatory learning.

In the study of Moore et al. (2011) entitled "*e-Learning, online learning, and distance learning environments: Are they the same*?" the researchers surveyed 43 persons to investigate the differences among perceptions of the terminologies used for this type of learning. The researchers found that there was a great difference in using the terminology among the sample. They concluded that the inconsistency of using the terminology would confuse researchers who build upon the findings of other studies, impact designs, and delivery and evaluation of such systems. Thus, to narrow down the scope of this research, and to focus on one specific context of e-learning and avoid generality, this research examines the developed model at a micro level, with a specific system provided by the context of the study (the University of Warwick) for the purposes of e-learning, namely Learning Management Systems (LMS), and more specifically, Moodle LMS. A deeper look at LMS definitions and types is given in the subsequent section.

2.2.2 Learning Management Systems (LMS)

In simple terms, an LMS is "a software application that is used to administer, track, report and deliver training" (Ellis, 2009). Another definition was introduced by Wahab (2008), namely that an LMS is "an integrated set of networked, computerized tools that support online learning (Virtual Learning Environment)". A further definition of an LMS is that it is "an information system to process, store and disseminate educational material and to support communication associated with learning" (McGill et al., 2008). In this research, we adopt the definition of an e-learning system as an information system. Thus, the success of e-learning systems is viewed as an information systems success.

An LMS also processes the learning content, allows for the creation of courses by uploading individual modules, and provides real time communication tools such as chat rooms to facilitate interaction for the corresponding course among students themselves and with the teacher. Additionally, it provides asynchronous communication functions such as e-mail, and discussion forums and supports other related learning matters (Lee and Lee, 2008; Sánchez and Hueros, 2010). Features like enrolment, reports, progression and performance, quizzes, journals, feedback, and marks are also available via a LMS.

Several other concepts relate to LMS, such as learning content management system (LCMS) and content management systems (CMS). Further, there are several types of LMS available to choose from. These maybe classified into two categories: commercial platforms and free open-source platforms. The most widely used commercial systems are Blackboard and WebCT. Moodle, meanwhile, is the most widely used open source platform (Sánchez and Hueros, 2010). In a comparison study between Moodle and Blackboard, Beatty and Ulasewicz (2006) claimed that Moodle might replace the Blackboard tool, and more effort is being made to evaluate Moodle. According to the Moodle website (2019)[2], there are 92974 currently active sites registered in 230 countries. Of these, 3421 are registered in the United Kingdom.

Moodle, a Modular Object Oriented Dynamic Learning Environment, is “an open source course management system for online learning” (Brandl, 2005). It was developed by Martin Dougiamas in 1988 to assist educators by providing a collaborative learning environment to create online courses. It provides tools that can be utilized to support traditional classroom courses, blended courses, or that can be used for distance learning. According to Brandl (2005) Moodle offers useful features and services to instructors, such as:

1. Accessing all lesson assignments;
2. Password restricted quizzes;
3. Automatic log reports of each student’s work (this includes knowing not only when students have completed or uploaded an assignment, but also how much time they spent on an assigned task or quiz);
4. Setting deadlines to submit assignments;
5. Downloading students’ grades;
6. Calendar;
7. Uploading a wide range of resources: HTML documents, and multimedia resources such as graphics, video, audio, and PowerPoint.

[2] Accessed March 1, 2019 from https://moodle.org/

Similarly, it provides students with services like:

1. Accessing learning materials;
2. Posting answers to the forum;
3. Chat and quizzes;
4. Uploading assignments in different formats;
5. Checking their grades;
6. Checking their deadlines using the calendar by moving the cursor over a day to list all the assignments for that day;
7. Providing feedback in both formats (quantitative and qualitative).

WebCT (Web Course Tools), or currently Blackboard, is a commercial learning management system (CMS) developed by Blackboard Inc.. This provides online elements to courses, ranging from face-to-face to complete online courses. Blackboard provides students with a communication and content platform. Communication functions comprise announcements, chat, discussions and mail. Content features comprise course content (to post articles, assignments, materials), calendar (due dates for assignments and tests), learning modules, assessments materials such as quizzes, assignments, grade book and a media library. According to the Blackboard website[3] they are serving over 16000 clients across 90 countries.

Many universities have invested substantial effort and a considerable amount of money in implementing e-learning systems. The utilization of e-learning software and platforms is deemed to be one of the most dominant and crucial investments in higher education in the last decade (Klobas and McGill, 2009). According to Dahlstorm et al. (2014), LMSs have been utilized by 85% of higher education institutions and 99% of institutions have an LMS in place. Despite e-learning's rapid growth and implementation, there continues to be a range of issues facing e-learning stakeholders. One of the key issues is evaluating e-learning success. Although considerable attention has been paid to e-learning success issue, there remain arguments about the determinants in measuring e-learning success (Al-Sabawy, 2013).

2.3 The Scope of the Literature Review in this Research

From the increasing interest in developing different kinds of e-learning programs, systems, and platforms, the following question arises: 'Is e-learning effective?' Considering the large investments and the abundant usage of these systems, evaluating e-learning systems has led

[3] Accessed March 1, 2019 from https://www.blackboard.com

to a considerable number of researchers developing robust models for assessing e-learning and searching for ways to improving the quality of these systems.

Using top journal databases (e.g., Computers and Education, Internet and Higher Education, ScienceDirect, Computers in Human Behavior, Taylor and Francis Online, etc.) and Google Scholar search engine, a total of 140 highly cited articles were selected to identify the models and theories developed to evaluate the success of e-learning systems. The topics of interest were e-learning in terms of evaluation, success, effectiveness, acceptance, quality, and models. These articles were selected based on their novelty, confidence in their empirical results, and the areas of concern. Reviewing the retrieved literature revealed four categories for measuring the success of e-learning: the DeLone and McLean information systems success model (D&M model); the Technology Acceptance Model (TAM); the User Satisfaction Models; and E-learning Quality Models (Al-Fraihat et al., 2018). More detail about each approach is given in the following four sections. In each section, the literature related to the success theories and models of information systems are initially discussed, followed by the literature on the success of e-learning systems.

2.4 E-learning Success based on DeLone and Mclean Information Systems Success Model

2.4.1 DeLone and McLean in the Context of Information Systems

Attempts to define the success of information systems have been shallow and imprecise, due to the complexity and interdisciplinary nature of this discipline (Petter et al., 2008). To address this, DeLone and McLean (1992) proposed a model to measure information systems success (D&M model) after reviewing 180 research papers published during the period 1981-1987 that sought to measure the success of information systems. The model contains six variables: system quality, information quality, use, user satisfaction, individual impact, and organizational impact (Figure 2.2).

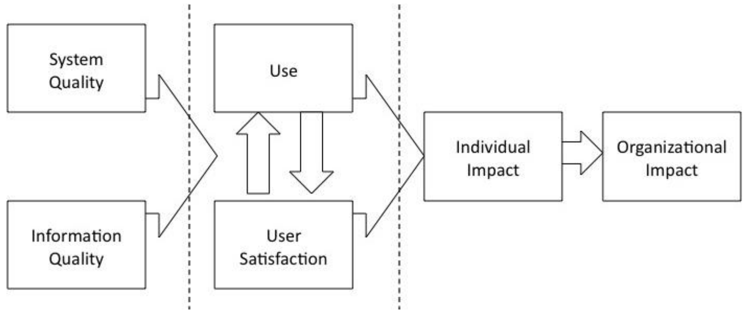


Figure 2.2: DeLone and McLean's IS success model (1992)

Indeed, the model is considered, more precisely, as a comprehensive framework or a taxonomy, since no empirical validation was proposed by the researchers. DeLone and McLean (1992) called for further development and validation of their model. Information systems researchers have attempted to examine this model partially or completely (e.g., Seddon and Kiew, 1994; Taylor and Todd, 1995; Jurison 1996; Igbaria and Tan, 1997). Seddon and Kiew (1994) were among the early researchers who partially tested the model and supported some of its paths. Other researchers (e.g. Pitt et al., 1995) incorporated 'service quality' into the model. Jurison (1996), in a longitudinal study, researched the nature of information systems benefits and argued that individual impact can be assessed first, but organizational impact needs a long period of time to be assessed. Igbaria and Tan (1997) tested the model and found a strong association between satisfaction and individual impact.

Seddon (1997) criticised DeLone and McLean model and considered the reciprocal relationship between use and user satisfaction very confusing. Seddon respecified the model and replaced 'system use' with 'perceived usefulness' of the model, with only one direction of causality. Rai et al. (2002) meanwhile conducted an empirical study, comparing DeLone and McLean's (1992) and Seddon's (1997) models, and proposing a new model which extended Seddon's model and included a correlational path between perceived usefulness and use (Figure 2.3). The relationship between perceived usefulness and system use was found to be greater than that of system use and perceived usefulness (path coefficient β = 0.65 in the first direction while 0.41 in the other direction).

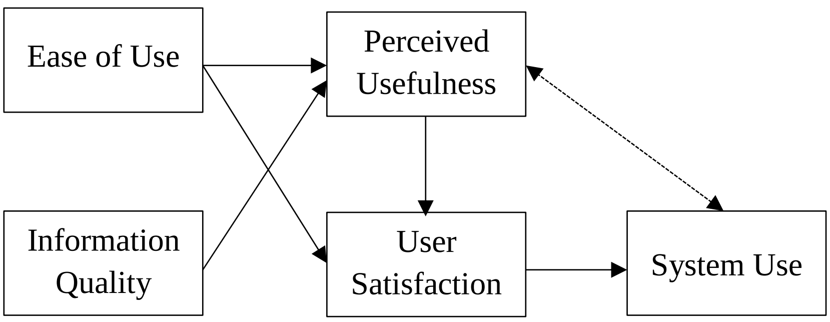


Figure 2.3: Information systems model of Rai et al. (2002)

Ten years later, DeLone and McLean updated their model, as shown in Figure 2.4. The new model introduced service quality as a new construct to the model; the use construct was split into two constructs, intention to use and use, to measure systems success in areas where the use of the system is voluntary and mandatory, and the two constructs, individual and organizational impacts, were merged into net benefits.

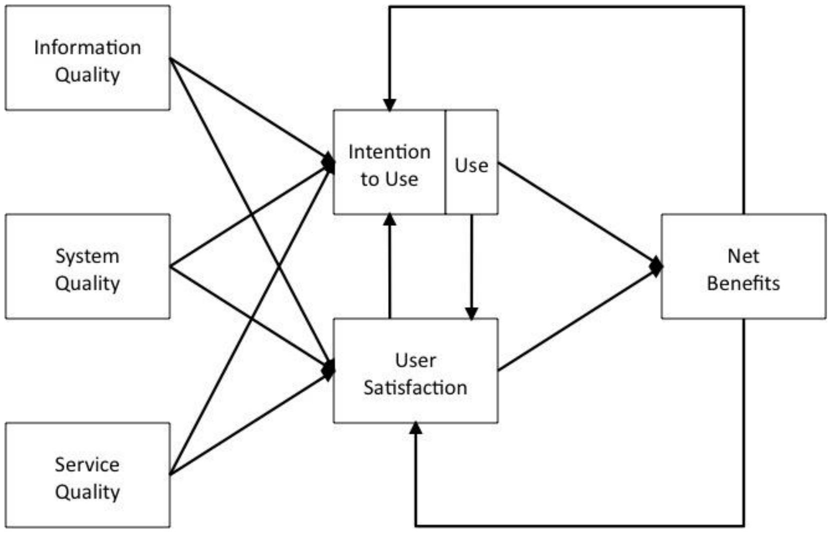


Figure 2.4: DeLone and McLean IS success model (2003)

The model may be interpreted as follows: "a system can be evaluated in terms of information, system, and service quality; these characteristics affect subsequent use or intention to use and user satisfaction. Certain benefits will be achieved by using the system. The net benefits will (positively or negatively) influence user satisfaction and the further use of the IS" (Urbach and Muller, 2012). The D&M model is considered one of the most influential theories and comprehensive models. It has been found to be useful, practical, and one of the best established models to measure information system success (Petter et al., 2008).

Researchers have adopted this model, either in full or part, to better understand the success of IS in different contexts at different levels (individual or organizational levels), such as e-commerce (Wang, 2008), Health Information System (Yousof et al., 2006); e-learning (Holsapple and LeePost, 2006); and knowledge management systems (Halawi et al., 2007). The DeLone and McLean model is believed to be a significant contribution to the information systems field. It has been adopted in different information systems and its validity has been proven in assessing the success of a range of different information systems. Some researchers have used this model at both individual and organization level. For example, in the context of an industrial information system, Rocky and Meriouh (2015) adopted the D&M model to evaluate the automotive industrial information system XPPS. Structural equation modelling (SEM) was used to analyse the quantitative results surveyed from 60 users of XPPS. All the relationships regarding intention to use were insignificant, and in addition, no relationship was found between either information quality or system quality and system use. Fewer than half of the relationships gained empirical support. However, the low sample size might be the reason for this. In addition, the minimum requirements of the sample size for SEM should be at least 200 to conduct the analysis of such a model (Kline, 2011). The model testing results showed that 18% of XPPS use was explained by this model, 53% of satisfaction, 31% of individual impact and 36.5% of organizational impact.

Petter and Fruhling (2011) also adopted the D&M model to evaluate the emergency response medical information system ERMIS using both individual and organization constructs. The results of their study showed that the overall quality (system, information, service) had a positive influence on user satisfaction and intention to use ERMIS. However, given the nature of the medical information system under investigation, overall quality did not predict use of the system. All other relationships were found to be significant. The researchers concluded that the context of the medical information systems needs to be considered when using the D&M information systems success model. Researchers supported the value of using the D&M model to evaluate ERMIS.

In similar vein, McGill et al. (2003) empirically tested the model in the domain of user-developed applications. Perceived system quality was added. Only intention to use was considered. Intention to use and user satisfaction were the determinants of individual impact which in turn influenced the organization impact (Figure 2.5)

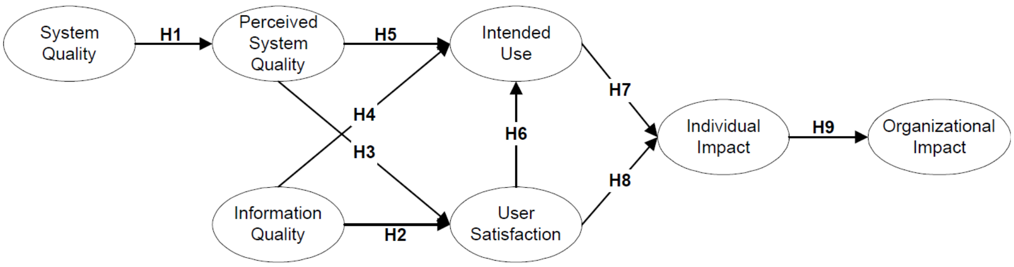


Figure 2.5: McGill et al. (2003) model

The results of testing the model showed that the model was partially supported by the data. Of the nine hypotheses, four gained empirical support. The researchers suggested that further research is needed to provide an appropriate model for user-developed applications. Other researchers have used this model at an organizational level only: for example, Park (2011) adopted this model to understand 'how does leadership affect information systems success?' 251 bank employees in Korea were surveyed. Results showed that transformational leadership positively influences the success of information systems.

Other directions of research have used this model at an individual level only (e.g. Iivari, 2005). The researcher tested the model in a mandatory information system. Service quality was not included in his model (Figure 2.6). The results show that both quality dimensions were significant determinants of user satisfaction, and explained 57% of the variance of user satisfaction, but not system use. User satisfaction was found to have a weaker influence on individual impact than satisfaction. The model explained 14% of the variance of actual system use, 57% of user satisfaction, and 35% of individual impact.

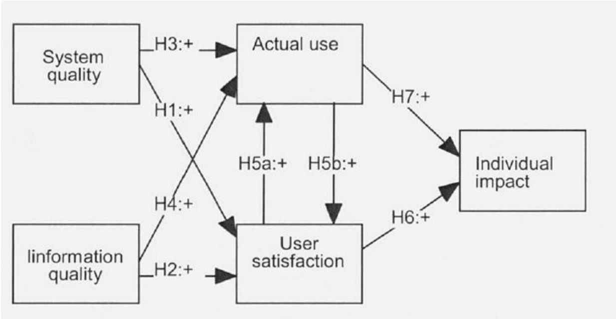


Figure 2.6: Iivari (2005) model

Table 2.1 summarizes selected highly cited studies from 2002 till 2018 (ordered by publication year) that have employed the D&M model to evaluate the success of a variety of information systems.

Author(s)	Context	Constructs	Results
Rai et al. (2002)	Information system for employees in a university	Ease of use, information quality, system dependence, user satisfaction and perceived usefulness	Information quality and ease of use were determinants of perceived usefulness and user satisfaction. Satisfaction and usefulness were determinants of system dependence. The results of testing the model showed that this model explained 55% of user satisfaction, 53% of system dependence, and 41% of perceived usefulness. The researchers concluded: "our results support DeLone and McLean's focus on integrated information systems success models and their observation that information systems success model need to be carefully specified in a given context".
McGill et al. (2003)	User developed application	System quality, perceived system quality, involvement, user satisfaction, individual impact and perceived individual impact	Two constructs were added to the model: user participation and involvement. Five relationships were significant and five were non-significant. 62% of user satisfaction was explained and 21% of the individual impact.
Bharati et al. (2004)	Web-Based Decision Support System	System quality, information quality, information presentation and satisfaction	System quality and information quality are positively correlated with satisfaction. There was no support for the relationship between information presentation and satisfaction.
Iivari (2005)	Mandatory information system in an organizational context	System quality, information quality, actual use, user satisfaction, individual impact	System quality and information quality are significant predictors of user satisfaction but not of system use. System quality was a significant predictor of systems use. User satisfaction is a strong predictor of individual impact. The relationship between system use and individual impact was insignificant. R^2 = 18% for system use; 58% for satisfaction and 35% for individual impact.
Wu and Wang (2006)	Knowledge management system KMS	System quality, knowledge information quality, perceived KMS benefits, user satisfaction, and KMS use	54% of the variance explained of KMS benefits, 69% of user satisfaction, and 60% of system use. The relationship between system quality and KMS benefits and between use and KMS benefits were insignificant. The other relationships were all significant. The study supported the model to evaluate the success of KMSs.

Hussein et al. (2007)	E-government	IS facilities, system quality, information quality, perceived usefulness, user satisfaction	The study findings indicate that all the technological factors are significantly correlated with the four IS success dimensions.
Wang and Liao (2008)	E-government	Information quality, system quality, service quality, use, user satisfaction, and net benefits	Except the link from system quality to use, the hypothesized relationships between the six success variables were significantly or marginally supported by the data. The model has explained 21% of use, 70% of user satisfaction and 40% of net benefits.
Chen and Cheng (2009)	Online shopping	Information quality, system quality, service quality, intention to use, use, satisfaction, usage value	R^2= 72% for intention to use, 59% for actual use, 48% for satisfaction, and 60% for usage value. Relationships between information quality, system quality, service quality and intention to use and satisfaction were all significant. Researchers stated that satisfaction does not warrant actual use in the context of online shopping, thus no direct relationship found between the two constructs. Intention to use is important to predict the usage behaviour of consumers.
Floropoulos et al. (2010)	Taxation information system	Information quality, system quality, service quality, and perceived usefulness	The results provide evidence that there are strong connection between the five constructs. All hypotheses were supported except for the relationship between system quality and satisfaction. 27.2% of the variance in employee's perceived usefulness in this model, and 25.7% of employees' satisfaction.
Petter and Fruhling (2011)	Emergency response medical information system ERMIS	System quality, information quality, service quality, user satisfaction, use, individual impact, and organizational impact	The study utilized the constructs of D&M to evaluate a medical information system. All relationships of D&M model were found significant with the exception between information quality and system quality. Individual impact showed greater influence on organization impact than system use, together they explained 40% of the variance of organizational impact.
Aggelidis and Chatzoglou (2012)	Hospital information system	Information quality, system quality, support in sourcing, support out sourcing and overall satisfaction	Service quality, use, and benefits were not included in their model. Support was added to the model. Information quality, system quality, support in sourcing, and support were all found to be determinants of satisfaction and explained 78.87% of the variance of overall satisfaction.
Balaban and Divjak (2013)	Portfolio system	Information quality, system quality, service quality, use, satisfaction, and net benefits	The model has explained 72% of net benefits, 48% of use and 53% of satisfaction. Results indicate that system quality has positively affected use of the ePortfolio, information quality has positively affected net benefits,

			service quality has a positive effect on both use and satisfaction, use has a significant positive effect on satisfaction, user satisfaction has a positive effect on net benefits, same for satisfaction and use, and benefits on user satisfaction. All paths were significant except the one from service quality toward use.
Alshibily (2014)	Human Resources Manager E-HRM	Information quality, system quality, service quality, user satisfaction, use, and perceived net benefit	All the constructs of the D&M were adopted. The model accounted for 63% of the variance in satisfaction, 45% of system use, and 49% of net benefit. All the relationships of the model were supported.
Rocky and AlMeriouh (2015)	Industrial Information System XPPS	Information quality, service quality, system quality, use, user satisfaction, individual impact and organizational impact	All the construct of the D&M were incorporated. The model explained 53.25% of the variance in user satisfaction, 47.95% of intention to use, 18.23% of system use, 31.21% of individual impact and 36.50 of organization impact. Six relations were significant and 8 found to be non-significant.
Tam and Oliveira (2016)	Mobile banking	System quality, information quality, service quality, use, user satisfaction, individual performance, technology characteristics, task characteristic, task technology fit	Three dimensions of task technology fit were added to the original model. Relationships between system quality and information quality on system use were partially supported, while service quality on use was not supported. The rest of the relationships were all supported. The model explained 72% of the variance in task technology fit, 56.9% on mobile banking use, 82.2% of user satisfaction, and 77.9% of individual impact.
Pratomo and Hapsari (2017)	Inventory Retail System	Information quality, system quality, service quality, and user satisfaction	The study results indicated that system quality positively affects user satisfaction of the supply system. On the other hand, variables of information quality and service quality were indicated to have no influenced to customer satisfaction.
Veeramootoo et al. (2018)	E-filing system	System quality, service quality, information quality, user satisfaction, confirmation, perceived risks, habit and continuance usage intention	Findings suggest that citizens' continuance usage intention of e-filing is influenced by system quality, user satisfaction, and habit. User satisfaction had the strongest impact on e-filing continuance usage intention. The study validated the use of IS success model to explore the factors affecting e-filing continuance usage.

Table 2.1: Selected studies that adopted D&M in their evaluation of Information Systems

2.4.2 DeLone and McLean in the Context of E-learning

As has been the case with information systems success studies, this model has been widely used to evaluate e-learning systems. Considering the nature of e-learning, the measures used to assess each construct have been adapted to fit the context of e-learning. Researchers have attempted to employ this model to evaluate their systems either in full or in part (the whole model constructs and relations). Other researchers have extended this model by adding other constructs, or have integrated this model with others to better understand the context of e-learning. Table 2.2 demonstrates selected, highly cited studies that have applied the model to evaluate the success of e-learning systems, with a brief summary of the results obtained. Looking at the success models developed over the years from 2002 to 2018 (Table 2.2), it can be noted that success measures have gradually evolved over the years. For example, the model developed by Wang et al. (2003) employed the same constructs of D&M and examined the relationships within the model by surveying 206 employees using an e-learning system in an organization. The model was empirically validated and further supported the D&M model.

In the e-learning success model constructed in 2006 by Holsapple and LeePost (Figure 2.7), the researchers adopted all the dimensions and relationships proposed by the D&M to investigate aspects of the success of an e-learning system at an American university among the three stages of e-learning system lifecycle: design, delivery, and outcome. The sample size was relatively low (72 students) and the model was not empirically validated against the data, nor was the relationship posited in the model examined. Instead, the researchers analysed the data descriptively. Thus, this is a limitation of their model. In addition, it is hard to compare the performance of their model with later models. The authors recommended that future research should empirically validate their model and extend it to include aspects of instruction.

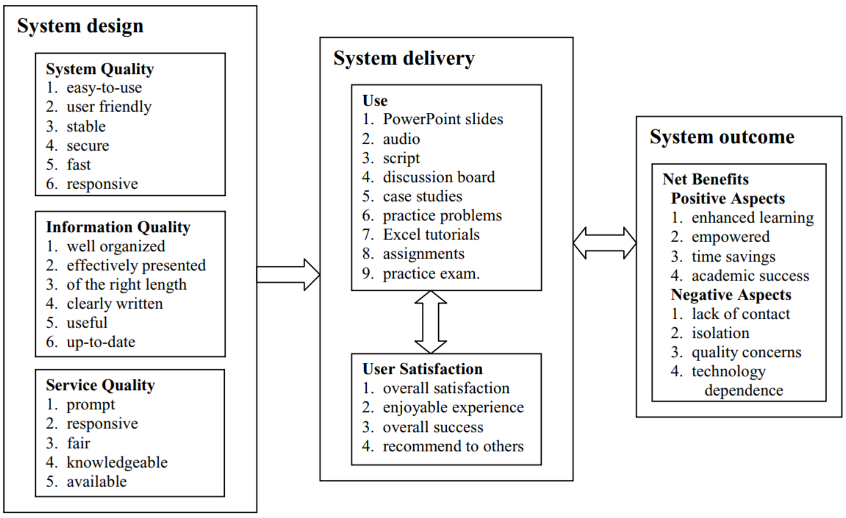


Figure 2.7: E-learning success model by (Holsapple and LeePost, 2006)

Later in 2007, further research was found that adopted the D&M approach with a focus on adoption and intention or continuous intention to use the system (e.g. Lin, 2007). There was a shift toward extending this model to explain the success of a variety of e-learning systems. For example, Chin-ChehYi et al. (2010) employed information quality, system quality and user satisfaction from the D&M model's constructs (Figure 2.8) to understand the factors that influence the intention to reuse a mobile learning system with 350 respondents. All relationships were found to be significant apart from the one between system quality and user satisfaction.

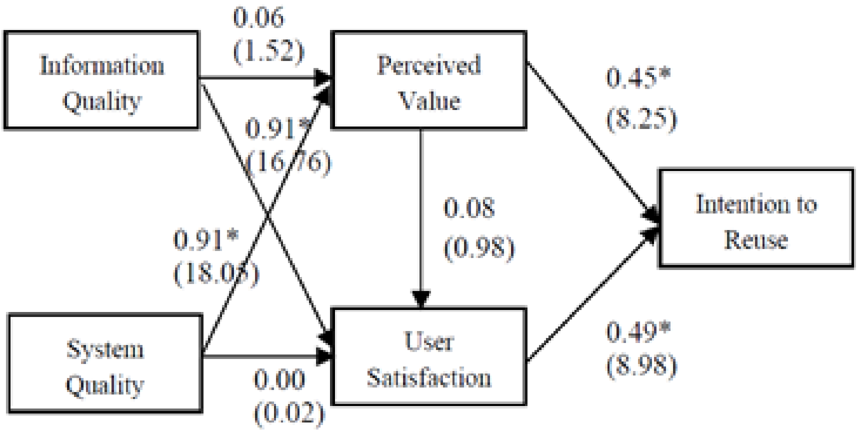
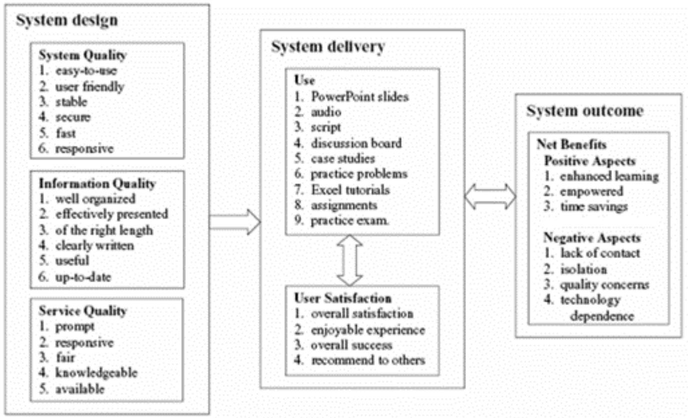
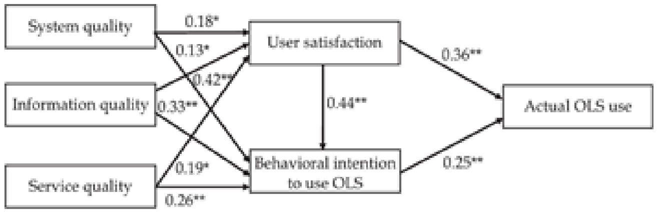
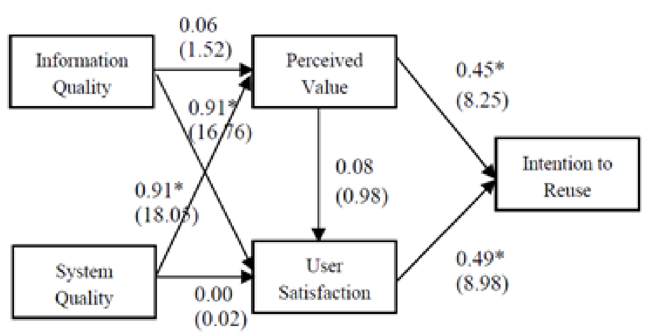
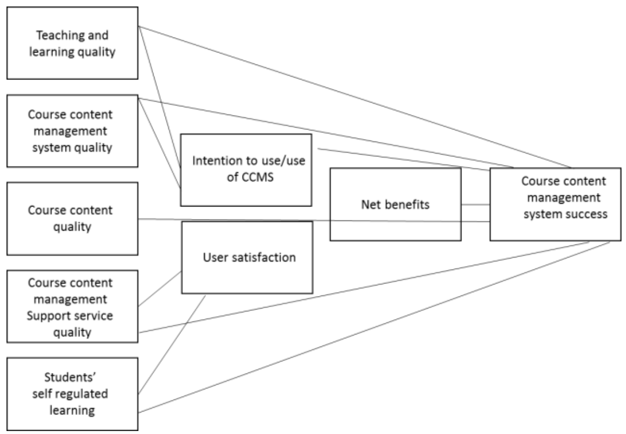


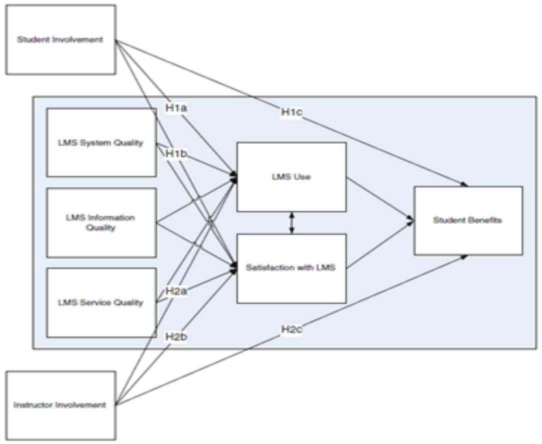
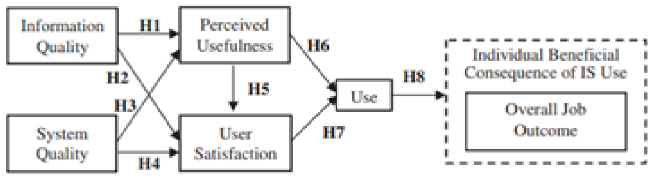
Figure 2.8: Model of Chin-ChehYi et al. (2010)

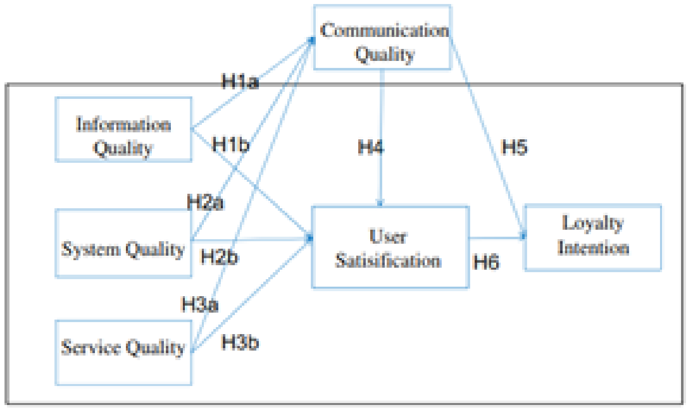
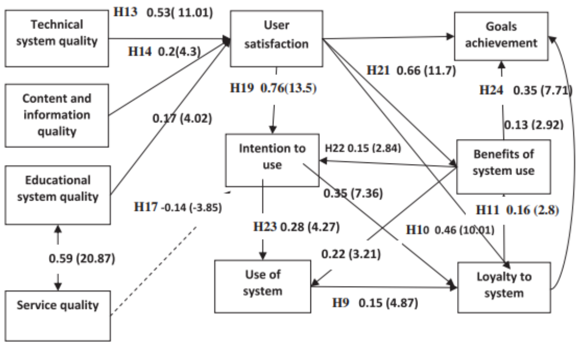
During the same period, 2010, more focus was given to aspects relating to students and instructors. For example, the model developed by Adeyinka and Mutula (2010) included students' self-regulated learning. Klobas and McGill (2010) added student involvement and instructor involvement to the D&M model. The model was empirically validated in the context of Australia with 244 students. The researchers found that the more students were involved with the LMS, the stronger the benefits obtained from using the system. The model explained 39.7% of the variance of the benefits of LMS, 57.3% of LMS satisfaction was explained in this model, and only 17% of LMS use.

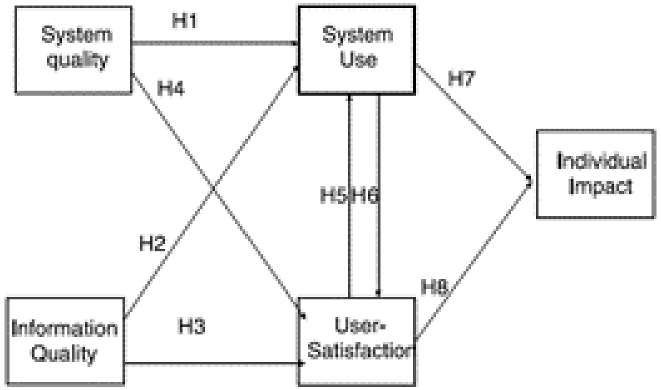
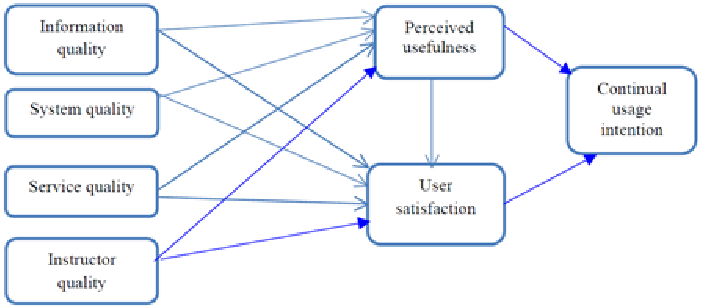
Another direction of research emerged by integrating this model with other models, and more interesting characteristics of instructor and learner were incorporated into the models. For example in the study conducted in Brazilian universities by Cidral et al. (2018), the researchers integrated the D&M model with the e-learning satisfaction model. Some characteristics of learner and instructor were considered in their model, namely learner computer anxiety and instructor attitude. The model was empirically examined with 311 students, and 11 relationships out of 19 gained empirical support. This model has explained 32.2% of the variation of system usage, 57.1% of user perceived satisfaction, and 52.5% of the individual impact.

Author	Sample	Model	Results/conclusion	Journal / Citation
Wang et al. (2003)	E-learning system, 206 employees	-	The study validated the D&M model, and emphasized the importance of evaluating the e-learning at various success levels: information quality, system quality, use, user satisfaction, and net benefit.	Computers in Human Behavior (506 citations)
Holsapple and LeePost (2006)	Online course, action research, 48 students in the first cycle, followed by 72 students in the second cycle, same students were once again asked to provide their feedback for the third and fourth cycles		The model considers three stages in the success of e-learning. The success of the system design stage is achieved by maximizing the three quality dimensions. The second stage of e-learning success improves the system delivery phase by increasing the use and user satisfaction dimensions. The final stage is to attain system outcome success by maximizing net benefits. Findings from the study confirm the validity of using the model for e-learning success assessment.	Decision Sciences Journal of Innovative Education (338 citations)
Lin (2007)	Online learning systems OLS, 232 students		The results provide an expanded understanding of the factors that measure OLS success. The results also show that system quality, information quality, and service quality had a significant effect on actual OLS use through user satisfaction and behavioural intention to use OLS.	Cyberpsychology & Behavior (225 citations)

Chin-ChehYi et al. (2010)	Mobile learning system, 350 respondents		The study validated part of the D&M model on m-learning context. Service quality was not considered. The use construct has been replaced by perceived value. The construct of net benefits was replaced by intention to reuse. The following factors influence users' satisfaction: information quality, system quality, perceived value, users' satisfaction, and intention to reuse. No relationship was found between system quality and satisfaction	International Journal of Human and Social Sciences (42 citations)
Adeyinka and Mutula (2010)	Online course management system WebCT, 503 students		The study findings suggest that content quality, system quality, support service quality, teaching and learning quality, self-regulated learning, intention to use/use, user satisfaction and net benefits are important factors in evaluating the success of WebCT CMS.	Computers in Human Behavior (74 citations)

Klobas and McGill (2010)	WebCT LMS, 244 students		The model has extended the D&M model by adding two constructs: student involvement and instructor involvement. Student and instructor involvement together explained 39.7% of the variance of the benefits of LMS. 57.3% of LMS satisfaction was explained in this model, and 17% of LMS use.	Journal of Computing in Higher Education (80 citations)
Chen (2010)	E-learning system in an organizational context, 190 employees		Usefulness predicts system usage, and system usage (in turn) predicts the overall job outcome. R^2 = 47% for perceived usefulness, 67.94% for user satisfaction, 52% for system usage, and only 20% for overall job outcome.	Computers & Education (140 citations)
Tella (2011)	Blackboard CMS, 503 students	-	The model was extended by adding the self-regulated learning construct. In summary, the study discovered that content quality, system quality, support service quality, teaching and learning quality, self-regulated learning, intention to use, user satisfaction, and net benefits are important dimensions for measuring Blackboard CMS success.	Journal of Information Technology Education (44 citations)

Wang and Chiu (2011)	E-learning system, 311 students,		This study applied the D&M success model to explore how to retain users and motivate them to continue using an e-learning system. Findings indicate that the improvement of information quality, service quality, system quality, and communication quality is very useful for sustaining loyal users of e-learning systems. Relationships were significant between information quality and system quality with communication quality, and insignificant between service quality and communication quality. However, better information quality did not satisfy users in the learning process. The other relations were all significant. The model explained 79% of the loyalty intention.	Computers & Education (127 citations)
Hassanzadeh et al. (2012)	E-learning systems in Iranian universities, 369 students and instructors		The model examined the D&M model by extending the model to include educational system quality, goals achievement, and loyalty to the systems. All relationships were significant except for service quality on intention to use the system. The model has 65% of the variance in user satisfaction, 67% of intention to use, 23% of system use, 73% of loyalty to the system, and 65% of benefits of using the system.	Experts Systems with Applications (180 citations)

Eom et al. (2012)	University e-learning system, 647 students		The model has been partially tested. The results indicate that system quality, information quality affected the two mediating constructs, system use and user satisfaction, which in turn influences the e-learning systems success. Researchers concluded that the D&M model has limited power to explain the outcomes of the learning due to the nature of the e-learning systems which are different from the environment in which D&M developed and tested their model. 29% of system use was explained, 82.7% of individual impact and 71.6% of user satisfaction.	Human Systems Management (32 citations)
Lwoga (2014)	Web-based LMS, 172 students		The model extended the D&M model by adding two constructs, instructor quality, and perceived usefulness. The model was partly used to measure the continual usage intention of a web-based learning management system. The relations between information quality and service quality on system use were insignificant, and also between service quality on perceived usefulness, and between perceived usefulness and continual usage intention. The model has explained 57.1% of perceived usefulness, 68.9% of user satisfaction, and 41.9% of continual usage intention.	International Journal of Education and Development using ICT (76 citations)

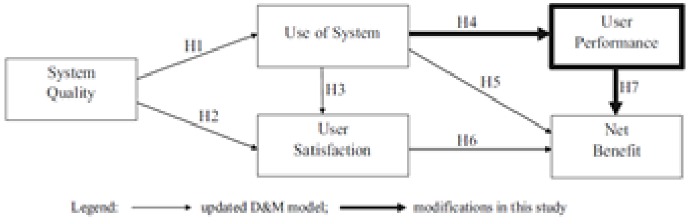
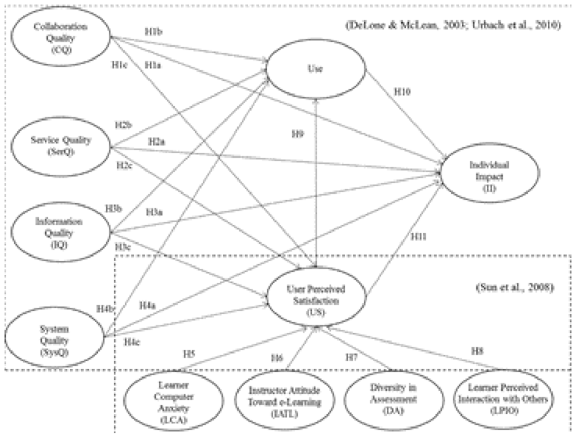
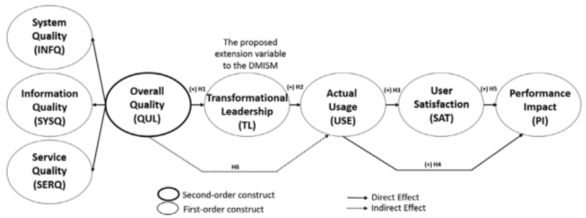
Marjanovic et al. (2015)	Moodle LMS, 279 employees		The success of e-learning was evaluated using four constructs of the D&M model: system quality, use, user satisfaction, and net benefits, and adding one more construct: user performance. The DeLone and McLean information systems success model applied equally well. The model explained 12.7% of Moodle LMS use, 14.3% of user satisfaction, 19.2% of user performance, and 44.2% of net benefits.	Information systems and e-Business Management (14 citations)
Cidral et al. (2018)	E-learning system in Brazilian Universities, 301 students		The model has extended the D&M model by adding (the concept of) collaboration quality construct. User perceived satisfaction was treated as a higher order construct, broken down into four constructs: learner anxiety, instructor attitude, diversity in assessment, and learner interaction. Eights relations were non-significant and twelve were significant This model has explained 32.2% of the variation of system usage, 57.1% of user perceived satisfaction, and 52.5% of the individual impact.	Computers & Education (16 citations)
Aldholay et al. (2018)	Online learning system in the main libraries of Yemen, 448 students		Transformational leadership was added to the model. The individual impact was renamed as performance impact. The model explained 61% of the variance in performance impact. 16.8% of the variance in system usage and 42.8% of user satisfaction.	Telematics and Informatics (12 citations)

Table 2.2: Selected studies that adopted D&M for evaluating e-learning systems

Surveying the literature reveals that there is a consensus about the validity of this model (or part of it) to evaluate the success of e-learning systems. However, there is a contradiction in the results among the studies. For example, while some studies have found that the overall quality aspects (system, information, and service quality) have a significant effect on actual system usage, other researchers have reported that this relationship is less significant. This could be due to the mandatory or voluntary nature of using the system (Eom et al., 2012). Another reason might be due to other intervening variables not being explained by the model. Moreover, results could be dependent on the context of the study and sample differences.

There are also differences between the variance explained (R^2) by quality factors among the dependent variables in these models. For this reason, Eom et al. (2012) stated that "the DeLone and McLean model has a limited explanatory power for explaining the role of e-learning systems on the outcomes of e-learning". Researchers have called for further research to investigate the quality factors of e-learning quality, so as to increase the explanatory power of the DeLone and McLean model (Eom et al., 2012; Eom 2015; Awang et al., 2018).

2.5 E-Learning Success based on Technology Acceptance Model TAM

2.5.1 TAM in the Context of Information Systems

The technology acceptance model (TAM) by Davis (1989) was the second direction for evaluating the success of information systems (Figure 2.9). It has been the most widely used theory to measure the success of new technology in terms of the acceptance and use of technology (Surendran, 2012). This model was established based on the Theory of Reasoned Action (TRA) and classified under theories of social psychology. The model suggests that when users are presented with new technology, a number of factors influence their decision as to how and when they will use it (Davis, 1989). Based on this model, external factors such as, social factors (e.g., skills, language), cultural factors, and political factors (i.e., the impact of using the technology in politics) are the determinants of perceived usefulness and perceived ease of use (Surendran, 2012). In turn, perceived usefulness and perceived ease of use are the major determinants of attitude toward using the technology and intention to use. Successively, behavioural intention to use is the main determinant of actual system usage.

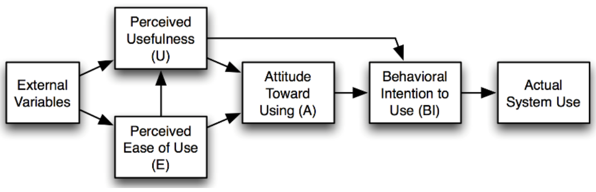


Figure 2.9: TAM (Davis, 1989)

A large number of studies have been conducted based on empirically testing the robustness and validity of this model, its instrument and measurement scale. The model has been widely extended using different variables. The model has been also successfully used to explain usefulness and usage in different contexts. An important extension (TAM2) to the original model was introduced in 2000 by Venkatesh and Davis (Figure 2.10).

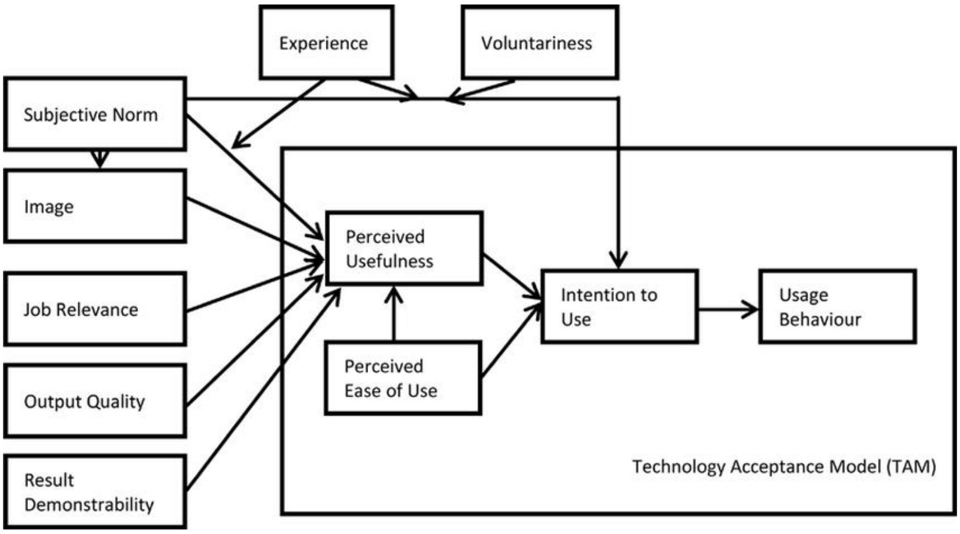


Figure 2.10: TAM2 (Venkatesh and Davis, 2000)

The model was tested in longitudinal research. It expanded the original model by adding the concepts of subjective norm, voluntariness, experience, and image (social influence processes). Job relevance, output quality, and result demonstrability were also added (cognitive instrumental processes). Empirical research has shown that TAM2 better explains user acceptance. Three years later, Venkatesh et al. (2003) constructed the Unified Theory of Acceptance and Use of Technology (UTAUT) (Figure 2.11).

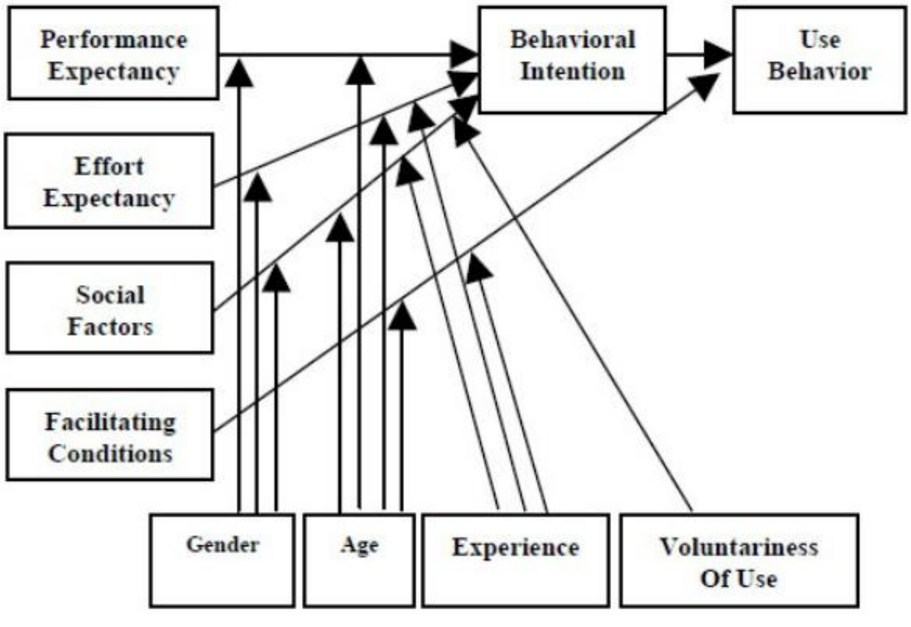


Figure 2.11: UTAUT (Venkatesh et al., 2003)

The introduction of UTAUT has significantly enhanced the explanatory power of usage intention, and has been widely used by researchers.

Extensions of TAM have constantly evolved over time. In 2008, a new model was released named TAM3 by Venkatesh and Bala (2008) (Figure 2.12), followed by UTAUT2 in 2012 (Figure 2.13).

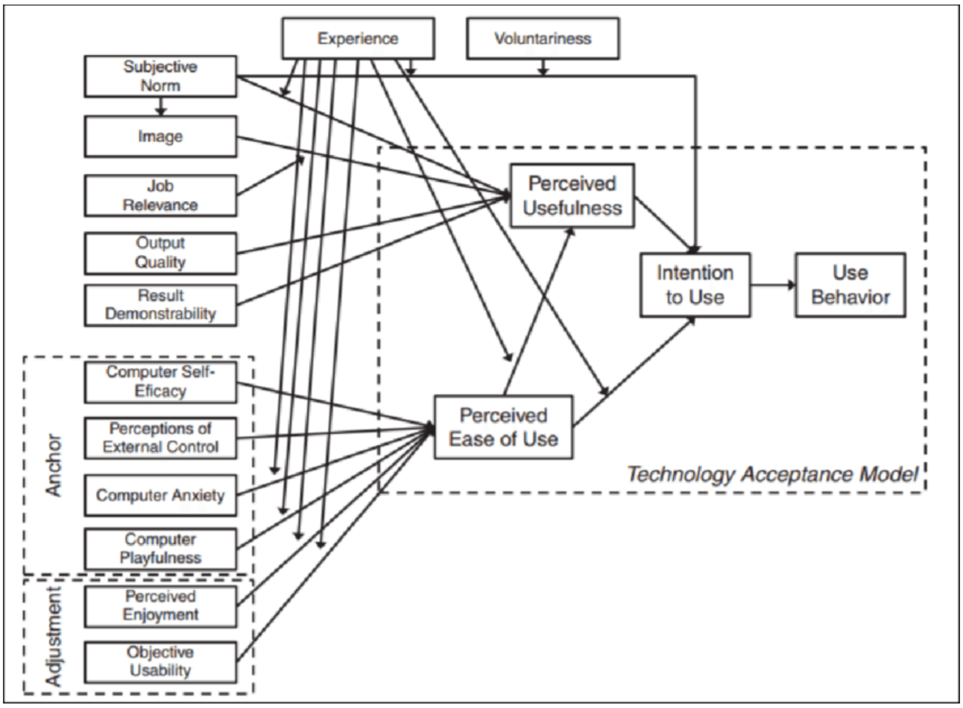


Figure 2.12: TAM3 (Venkatesh and Bala, 2008)

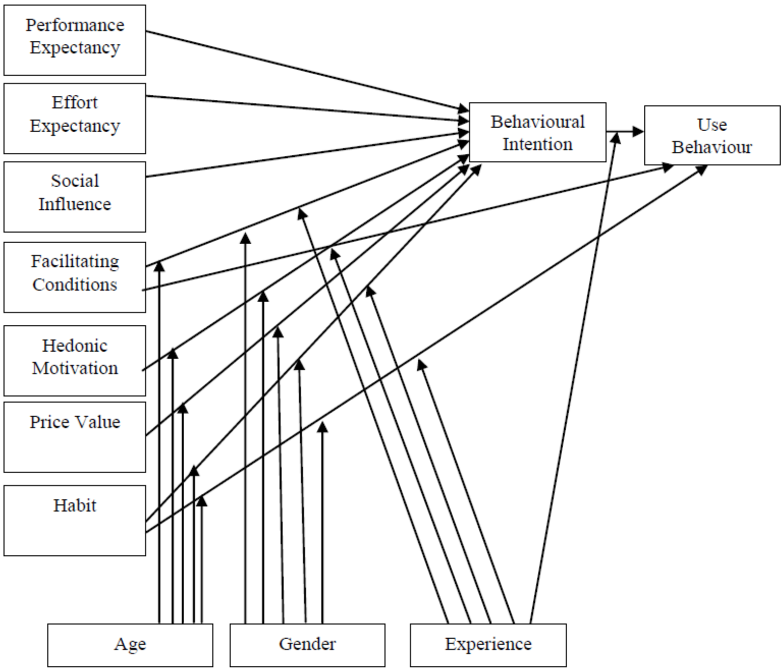


Figure 2.13: UTAUT 2 (Venkatesh et al., 2012)

TAM, in its different versions – TAM, TAM2, TAM3, UTATUT, and UTAUT2 – has received considerable attention from researchers in different fields and have been empirically examined, extended and validated to determine factors that affect the intention to use, usage, ease of use, usefulness and overall acceptance of new technologies and information systems. Table 2.3 presents selected studies from 2002 till 2018 (ordered by publication year) that adopted TAM in various types of information system.

Author	Context	Study/ Conclusion
Dasgupta et al. (2002)	E-collaboration	TAM was adopted to investigate user acceptance of electronic collaboration technology. The constructs are ease of use, usefulness, usage and individual performance.
Pavlou (2003)	E-commerce	A model developed to predict the acceptance of e-commerce system. Two new variables were added to TAM: trust and perceived risk.
Pikkarainen et al.(2004)	Online banking	TAM was utilized to understand the acceptance of online banking system. TAM variables were used in addition to perceived enjoyment, security and privacy, quality of internet connection and information. Among these variables, information and perceived usefulness were important factors to online banking use.
Olivera and Joia (2005)	E-retailing	TAM was adapted to understand the features that influence the user purchasing process of a virtual store website.
Porter and Donthu (2006)	Internet usage	A model to explain demographic-based differences of Internet usage. TAM was extended by including perceived access barriers. Age, education, income, and race are associated differentially with beliefs about the Internet, and these beliefs influence attitude towards Internet usage.
Amoako-Gyampah (2007)	Enterprise resource planning (ERP)	A model to examine factors that increase implementation success when adopting ERP systems. Two factors were added and found to influence perceived usefulness: argument for change and intrinsic involvement.
Chen (2008)	Mobile payment	A model developed to understand the determinants of consumer acceptance of mobile payment by expanding the Technology Acceptance Model (TAM) and the Innovation Diffusion Theory (IDT).
Muller-Seitz et al. (2009)	Radio frequency identification (RFID)	TAM was used to understand the acceptance of RFID. The researchers concluded that TAM was overall appropriate. However, refinements to the model are needed.
Ervasti and Helaakoski (2010)	Mobile service	A model to understand mobile service adoption. Perceived usefulness is the main determinant of mobile service adoption.
Lin et al. (2011)	E-government	A model to assess citizen adoption of e-government initiatives. Constructs of the TAM have strong influences on user-intention towards e-Government products.

Chow, (2012)	Healthcare system (Second Life)	A model developed to explore the intention to use Second Life for enhancing healthcare education. Computer self-efficacy construct was added as an external variable to TAM.
Lee and Lehto (2013)	YouTube acceptance	A model to identify the determinants affecting behavioural intention to use YouTube. User satisfaction, content richness, vividness, and YouTube self-efficacy, as well as content richness, were incorporated into the TAM.
Rauniar et al. (2014)	Social media usage	A model to understand the drivers of social media usage behaviour.
Kim and Shin (2015)	Smart watches	A model to identify the determinants of smart watch adoption (i.e., affective quality (AQ), relative advantage (RA), mobility (MB), availability (AV), subcultural appeal).
Kardooni et al. (2016)	Renewable energy	A model to investigate the factors that influence renewable energy technology acceptance. In addition to studying the impact of cost and knowledge on the perceived ease of use and perceived usefulness of renewable energy technology.
Lin (2017)	Nursing information system	A model to understand nurses' perceptions and how technological functionality affects their satisfaction with the nursing information system.
Taherdoost (2018)	E-service	A model to identify the main factors influencing the acceptance of e-service. Quality, security and satisfaction are determinants of the intention to use an e-service and consequently the acceptance of e-service technology.

Table 2.3: Selected studies that adopted TAM in their evaluation of information systems

2.5.2 TAM in the Context of E-learning

Studies carried out with TAM in the context of e-learning systems, similarly, have used the model to predict usefulness, intention to use and usage of e-learning systems. Researchers extended the model by adding external variables to understand the determinants of e-learning systems' acceptance and usage. The external variables assisted researchers in understanding why a particular system may or may not be adopted, thus appropriate 'corrective steps' can be taken (Davis et al., 1989). Based on the literature study conducted by Abdullah and Ward (2016), the five most widely used external factors by researchers, and confirmed to have a relationship with TAM in the context of e-learning are: self-efficacy, subjective norm, enjoyment, computer anxiety, and prior experience. Table 2.4 presents selected, highly cited studies from 2002 to 2018 (ordered by publication year) that adopted TAM in various types of e-learning system.

As can be seen from Table 2.4, e-learning researchers have used this model widely to evaluate the success of various kinds of e-learning system (Blackboard, Moodle, mobile learning systems, MOOCs, web-based courses etc.). It has been the most widely-used acceptance theory in e-learning acceptance research (Šumak et al., 2011).

The success of e-learning systems was measured in these models through acceptance, adoption and usage behaviour, e.g. students' intention to adopt e-learning (Wahab, 2008); explaining and predicting users' continuance intention toward e-learning (Lee et al., 2009); understanding university students' behavioural intention to use e-learning (Park, 2009); examining use of LMSs in higher education (Fathema et al. 2015); investigating usage outcomes by Islam (2013).

As Sharma and Chandel (2013) have stated: "There is an important need to investigate the factors influencing the use and acceptance of e-learning to make it an effective tool in education". Pituch and Lee (2006) also concluded: "The benefits of an e-learning system will not be maximised unless learners use the system". Thus, for the success of e-learning, it is indispensable to investigate the determinant factors that impact the e-learning systems' usage and acceptance.

The vast majority of research has adopted the TAM and extended it by incorporating several external variables (e.g., system quality, experience, subjective norms, self-efficacy, support, anxiety) to identify the factors that explain users' decisions to use or continue to use the e-learning system. A positive explanation for the reason that urges researchers to extend the model was proposed by Mathieson (1991): "TAM only supplies very general information on users' opinions about a system", and explained that "it does provide little specific information that can better guide system development compared with theory of planned behaviour TPB".

In the same context, namely TAM in e-learning, e-learning researchers have been interested in finding the external variables to examine their impact on the two main determinant constructs in TAM, perceived usefulness and perceived ease of use, which in turn influence students' attitudes towards using the e-learning system. Successively, students' attitudes toward using the e-learning system influence their behavioural intention to use it, which in turn determines actual usage of the e-learning system (Figure 2.14).

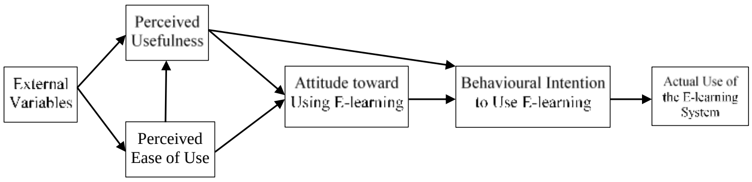


Figure 2.14: Technology Acceptance Model (Davis, 1989) in E-learning

Researchers have produced a large number of models with different external variables, with a focus on the total amount of variance explained by these variables, to explain why some e-learning systems are successful (Petter et al., 2008). For example, Selim (2003) used TAM to empirically investigate students' acceptance of course websites among 403 students in the context of the Middle East. They utilized three key constructs: TAM course website usefulness (CWU), course website ease of use (CWEOU), and course website use (CWUSE) (Figure 2.15). Acceptance of the course website was assessed by use. Usefulness and ease of use considerably explained 83% of the variance of course website use. Ease of use was strongly correlated with usefulness (path coefficient β = 0.78) and explained 61% of the variance of course website usefulness. The model fitted the data well and achieved high predictive power. The study revealed critical variables that influence the success of an e-learning system, these being interactivity, discussion forum, diversity of learning styles, existence of course related materials and further references in the e-learning system, accomplishing course work quickly through animation and multimedia modules, availability of information, and understandability. The model validated and strongly supported the TAM in explaining the success of course websites in terms of acceptance and usage.

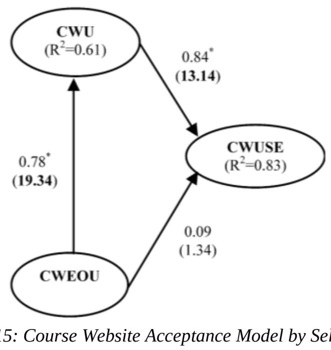


Figure 2.15: Course Website Acceptance Model by Selim (2003)

Other researchers extended the model by incorporating other factors into TAM. In this respect, Lee et al. (2009) established a model to investigate factors relating to e-learning adoption in South Korea (Figure 2.16). The model operationalised four independent constructs, namely instructor characteristics, teaching materials, design of learning contents, and playfulness, to explain the two dependent variables, perceived ease of use and perceived usefulness, which in turn determine intention to use e-learning.

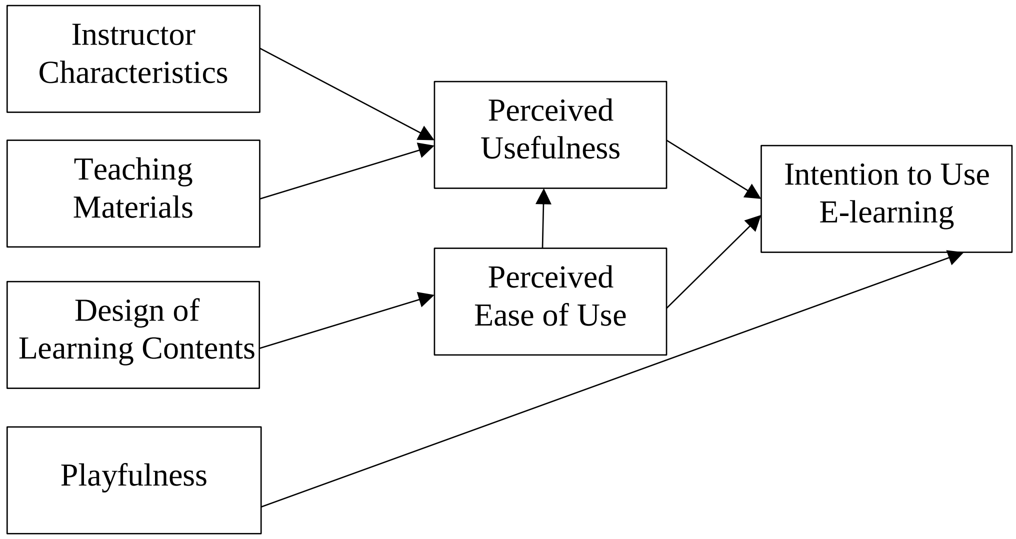


Figure 2.16: The research model developed by Lee et al. (2009)

The researcher used regression analysis to test the model due to sample size (N= 214). All relationships were found to be significant in this model. The model showed that instructor characteristics form the most important determinant of perceived usefulness (explained 43.3% of usefulness) followed by ease of use (explained 38.9% of usefulness) and teaching materials (23.5% of usefulness). The results also indicated that perceived ease of use had the weakest effect on intention to use e-learning (explained 11.7% of intention) while perceived usefulness was the strongest.

Similar to this type of model was the model proposed by Pituch and Lee (2006). The external variables utilized in their model were: system functionality, system interactivity, system response, self-efficacy, and Internet experience. All these independent variables were proposed as determinants of perceived usefulness and perceived ease of use, which in turn influenced the use of supplementary learning (USL) and the use of distance education. The results of testing the model's hypotheses showed no significant effect of self-efficacy and Internet experience on both use of distance education and perceived usefulness or perceived ease of use.

Another direction of using the TAM in e-learning research is to integrate this model with other models. In this vein, a significant study by Roca et al. (2006) integrated TAM with ‘Expectancy Disconfirmation Theory (EDT)’. In addition to EDT, the researchers incorporated in their model the three quality factors from the D&M information systems model and subjective norm (which measures the social influence on users’ attitude) (Figure 2.17). The study was conducted to understand the variables that motivate students to continue using an e-learning course. The researchers argued that integration is needed to better identify the factors that explain a user’s decision to continue using the e-learning system.

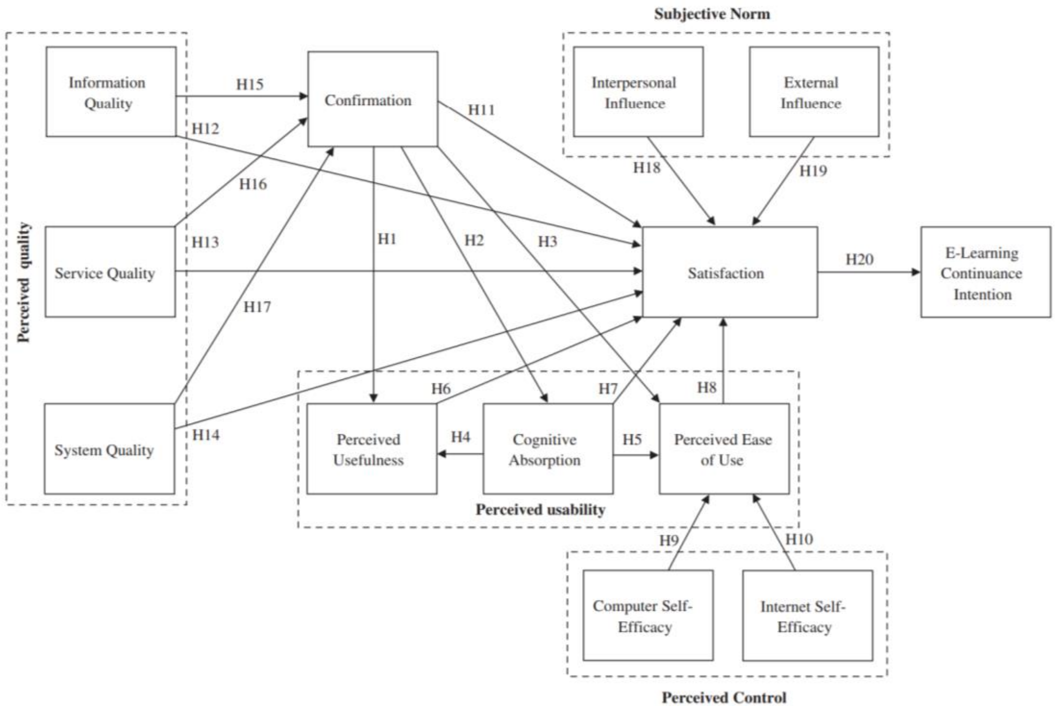
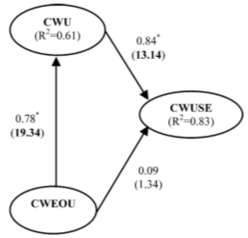
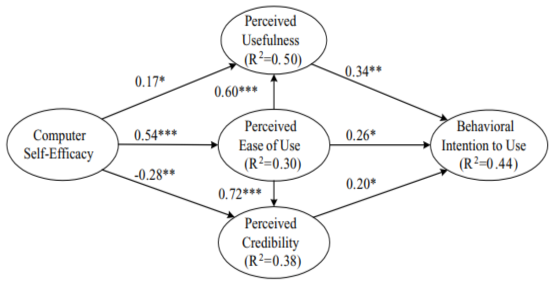
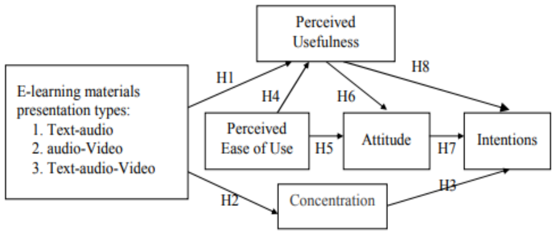
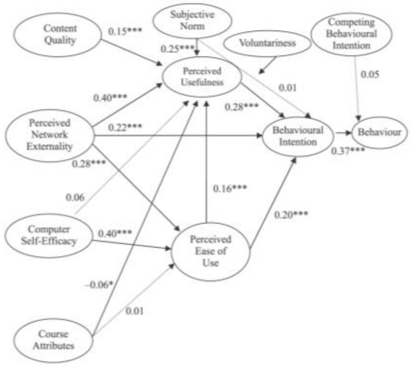
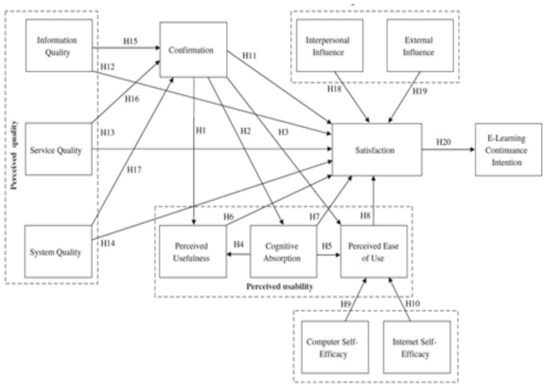
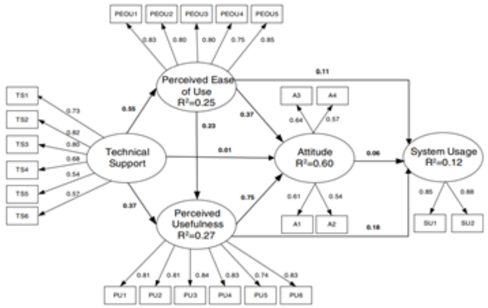


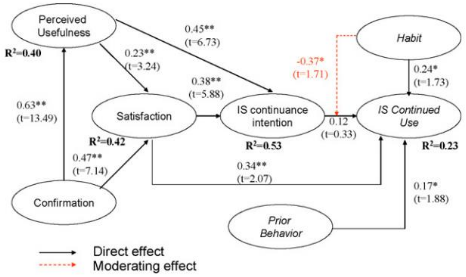
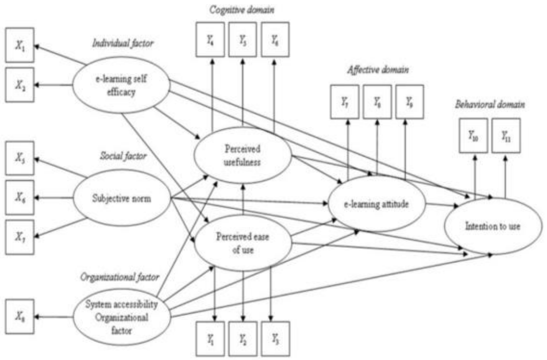
Figure 2.17: Roca et al. (2006) model

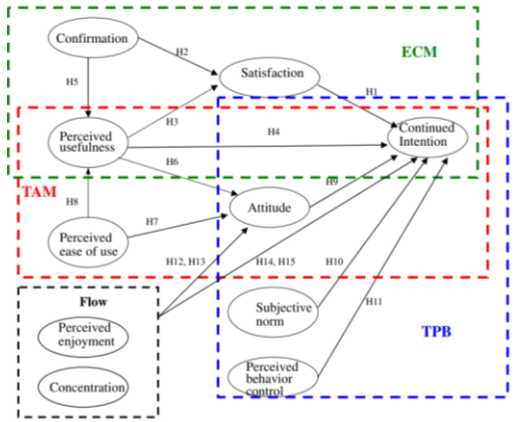
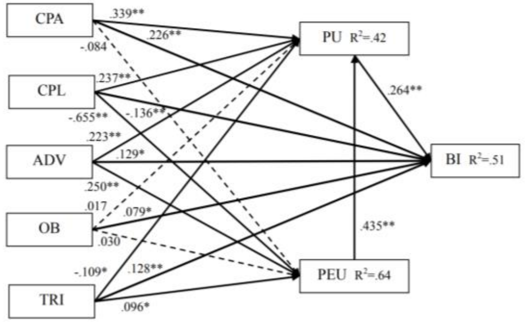
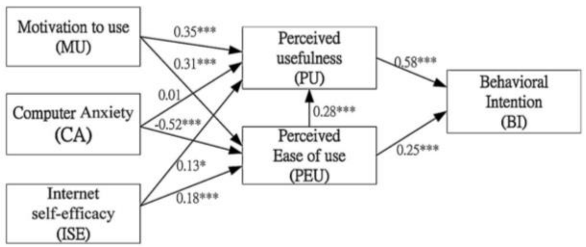
Perceived usability, confirmation, subjective norm, and perceived quality are all assumed to influence satisfaction, which in turn, determines e-learning continuance intention. The model was tested by surveying 172 employees among four international agencies of the United Nations using an online questionnaire. The results of testing the measurement model showed acceptable values for the reliability of the constructs selected. Interpersonal influence registered the lowest Cronbach alpha = 0.67 and showed no significant relation with satisfaction. The model explained 37.6% of the variance of e-learning continuance intention. Arguably, considering the complexity of their model (13 constructs, and 20 hypotheses) and the procedure used for testing the structural model, SEM, the sample size used in their study is not sufficient to empirically evaluate the research model using this approach.

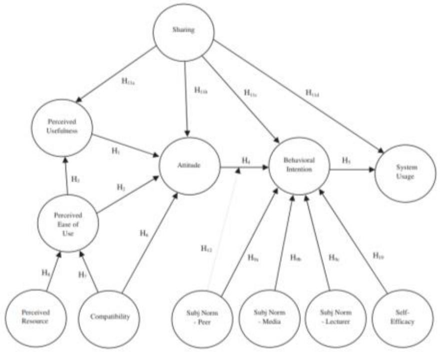
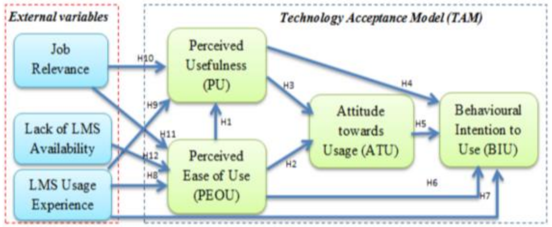
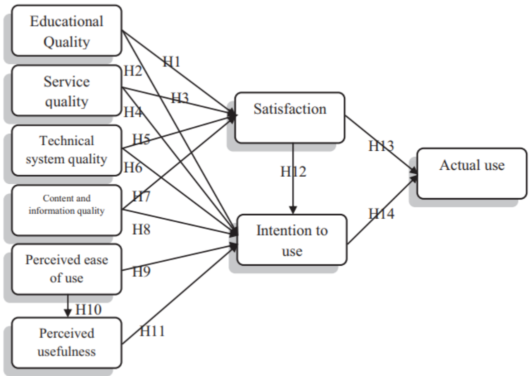
More studies that adopted the TAM in e-learning research are summarized in Table 2.4.

Author(s)	System/ Sample	Model	Results/Conclusion	Journal
Selim (2003)	Course Website CW, 403 students		The study used constructs of usefulness and ease of use from TAM to assess university students' acceptance of course websites. 83% of the total variance in the course website acceptance and usage were explained in this model.	Computers & Education (455 citations)
Ong et al. (2004)	E-learning system in high tech companies, 140 engineers		A new construct was added, namely perceived credibility, to examine the applicability of TAM in explaining engineers' decisions to accept e-learning. The results strongly support TAM in predicting engineers' intention to use e-learning. All relationships were found significant except the one from computer self-efficacy to perceived credibility. The model explained 50% of the variation of perceived usefulness and 44% of behavioural intention to use, 30% of perceived use and 30% of perceived credibility.	Information & Management (726 citations)
Liu et al. (2005)	Web-based e-learning system, 88 students		TAM was integrated with flow theory to investigate users' acceptance behaviour. All relations were found significant except the one from concentration to intentions. The model explained 21% of usefulness, 49.4% of attitude, and 56% of intentions. The study found that the most media-rich presentation interface (text-audio-video based presentation) generated higher levels of perceived usefulness and concentration than text-audio and audio-video based presentations.	E-learning (453 citations)

Lee (2006)	Web-based e-learning system, 1085 students		TAM was extended to investigate the factors affecting the adoption of e-learning systems ELS in mandatory and voluntary settings. The results confirm the original TAM findings. The model explained 30% of behavioural intention, 35% of perceived usefulness, and 30% of perceived ease of use.	Online Information Review (321 citations)
Roca et al. (2006)	E-learning system, 172 students		TAM was integrated with expectancy disconfirmation theory (EDT) to investigate determinants of e-learning continuance intention. The study found that users' continuance intention is determined by satisfaction. Satisfaction, in turn, was determined by perceived usefulness, information quality, confirmation, service quality, system quality, perceived ease of use and cognitive absorption. The model has explained 65% of the variance in e-learning satisfaction and 37.6% of e-learning continuance intention.	International Journal of Human-Computer Studies (1095 citations)
Ngai et al. (2007)	Web Course Tools (WebCT), 836 students		TAM was extended to incorporate technical support. The results showed that technical support has a significant direct effect on perceived ease of use and usefulness, and ease of use and usefulness are the major factors affecting students' attitudes using WebCT. The model explained 25% of perceived ease of use, 30% of students' attitude, 27% of	Computers & Education (722 citations)

			perceived usefulness and 12% of system usage.	
Limayem and Cheung (2008)	Blackboard learning system, 505 students		Confirmation and perceived usefulness are determinants of satisfaction. The model explained 53% of continuance intention to use Blackboard.	Information & Management (408 citations)
Park (2009)	E-learning system, 628 students		A model to understand the process of how university students adopt and use e-learning. The model provided support for TAM to be a good theoretical tool to understand users' acceptance of e-learning. E-learning self-efficacy found the most important construct, followed by subjective norm in explicating the causal process in the model.	Educational Technology & Society (1097 citations)

Lee (2010)	Web-based learning system, 363 learners		The model integrated TAM with expectation-confirmation model ECM and the theory of planned behaviour TPB. The results show that satisfaction has the most significant effect on users' continuance intention, followed by perceived usefulness, attitude, concentration, subjective norm, and perceived behaviour control as significant but weaker predictors. The model explained 65% of the variance of satisfaction, 67% of the variance of attitude, 6% of perceived usefulness and 8% of continued intention.	Computers & Education (723 citations)
Lee et al. (2011)	E-learning system, 552 employees		TAM was integrated with the innovation diffusion theory IDT. The results show that the five variables – compatibility, complexity, observability, relative advantage, and trialability – significantly influenced employees' e-learning system behavioural intention. These variables accounted for 51% of the variance of behavioural intention.	Educational Technology & Society (387 citations)
Chen and Tseng (2012)	Web-based e-learning system, 402 teachers		TAM was utilized to investigate the factors that influence the acceptance of web-based e-learning system of teachers in Taiwan. Results showed that perceived usefulness and motivation to use were the primary reasons for teachers' acceptance of web-based e-learning system.	Evaluation and Program Planning (151 citations)

Cheung and Vogel (2013)	A collaborative platform, 136 students		TAM was extended to predict user acceptance of Google applications for collaborative learning. The model explained 70% of the variance of attitude, 62% of behavioural intention, and 39% of system usage.	Computers & Education 398 citations
Alharbi and Drew (2014)	Learning Management System LMS		TAM was adapted to understand academics' behavioural intention to use learning management systems. The model added job relevance, lack of LMS availability, LMS usage experience as external variables to the original model. The results show that external variables affect the overall intention to use an LMS.	Journal of Advanced Computer Science and Applications (184 citations)
Mohammdi (2015)	E-learning system, 390 students		The study has integrated TAM with D&M IS success model to investigate users' perspectives on e-learning. The results reveal that intention and user satisfaction both had positive effects on the actual use of e-learning. System quality and information quality were found to be the primary factors driving users' intentions and satisfaction towards the use of e-learning. Perceived usefulness mediated the relationship between ease of use and users' intentions. The model explained 73.7% of the variation of actual use, 63.12% of intention to use, 22.2% of satisfaction and only 2.3%, of perceived usefulness	Computers in Human Behavior (179 citations)

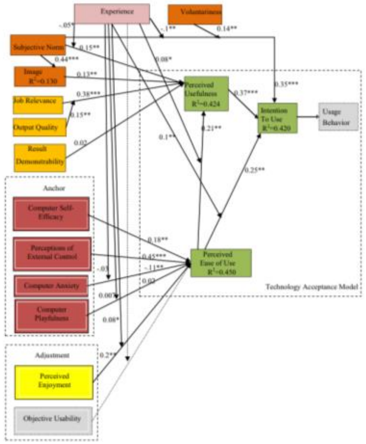
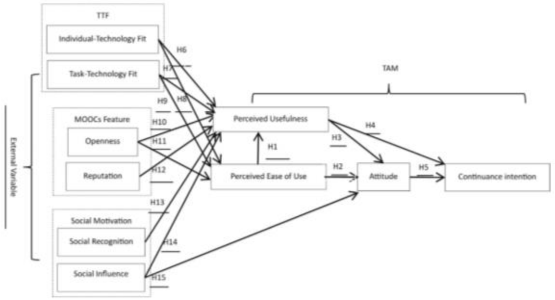
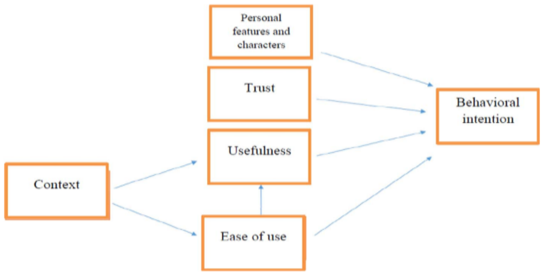
Al-Gahtani (2016)	Learning management Systems LMS, 286 students		The research adopted TAM3 to investigate e-learning acceptance and assimilation. All hypotheses of TAM3 were supported except the two relationships: computer playfulness and perceived ease of use; and results demonstrability and perceived usefulness. The model explained 42.4% of the variance of perceived usefulness, 42% of intention to use, and 45% of perceived ease of use.	Applied Computing and Informatics (89 citations)
Wu and Chen (2017)	Massive Open Online Courses MOOCs, 252 participants		The research integrated TAM and task technology fit TTF to investigate factors influencing continuance intention to use MOOCs in China. All relationships found significant except perceived ease of use and social influence on attitude; and individual-technology and openness with perceived usefulness.	Computers in Human Behavior (82 citations)
Hamidi and Chavoshi (2018)	Mobile learning 300 participants		A model to evaluate the factors for the adoption of mobile learning. Results show that the six categories of factors: ease of use, trust, characters and personal qualities, context, perceived usefulness of using, behavioural intention, and culture of using a research model are the main factors influencing the adoption of mobile learning.	Telematics and Informatics (23 citations)

Table 2.4: Selected studies that adopted TAM in their evaluation of Information Systems

According to the review conducted by Šumak et al. (2011), TAM is the most popular theory adopted in e-learning acceptance research, with 86% of studies utilizing this model as a ground theory. Though acceptance and use are necessary to measure success, they are not the same as success (Petter et al., 2008). The model has been widely criticised despite its frequent use. As Chuttur (2009) has stated: "Researchers share mixed opinions regarding its theoretical assumptions and practical effectiveness". Meanwhile, Legris et al. (2003) have concluded thus: "TAM is a useful model but has to be integrated into a broader one which would include variables related to both human and social change processes". Moreover, researchers have criticised the poor fit of this model, its limited explanatory and predictive power and lack of practical value (Legris et al., 2003). To illustrate, both TAM and TAM2 explained about 40% of system use (Legris et al., 2003), while researchers extended TAM and provided better explanatory power models with a total variance explained ranging from 52%-70% (Abdullah and Ward, 2016). Furthermore, researchers claimed that several attempts to expand this model led to "theoretical chaos and confusion" (Benbasat and Barki, 2007).

2.6 E-learning Success based on User Satisfaction Models

2.6.1 User Satisfaction Models in the Context of Information Systems

Another significant direction of information systems research is the user satisfaction approach. Satisfaction has been found to be a fundamental measure in the success, effectiveness, usage, and acceptance of information systems (Bailey and Pearsons, 1983; Ives et al., 1983; Doll and Torkzadeh, 1988; DeLone and McLean, 1992; Thong and Yap, 1996; Harter and Hert 1997; Seddon, 1997). There is wide agreement that satisfaction is an attitude held by individual users (Thong and Yap, 1996). Remenyi and Money (1991) defined user satisfaction as a measure of the discrepancy between user's expectations about a specific information system and the perceived performance of the system. Cyert and March (1963) are believed to be the first researchers to introduce the concept of user satisfaction to assess the success of information systems. They suggested that if an information system meets users' needs, their satisfaction will increase with the information system. Similarly, Evans (1976 cited in Thong and Yap, 1996) stated that a lower satisfaction level with regard to the information system will hinder system usage. Seddon and Kiew (1994) concluded that user satisfaction is the most general and important measure of information systems success. Similar results were achieved by Igbaria and Tan (1997).

The first empirical attempt to identify user satisfaction as a measure of information systems success was by Bailey and Pearson (1983), who developed an instrument with 39 factors for measuring computer user satisfaction. A shorter condensed instrument, with 13 factors, was produced by Ives et al. (1983). Goodhue (1986) criticised Ives et al.'s (1983) instrument, considering that it lacked strong theoretical support. Later, Baroudi and Orlikowski (1988) empirically validated their short instrument.

The contribution of user satisfaction studies continued. A highly rated reliable questionnaire to measure user satisfaction was proposed by Chin et al. (1988). In 1992, DeLone and McLean employed satisfaction as a single construct in their model, due to its high degree of reliability and validity compared with other measures. Further, Doll et al. (2004) provided a 12-item valid scale for end-user computing satisfaction EUCS.

Different approaches have been used to measure user satisfaction. One direction is based on assessing the level of satisfaction of the specific instance of information system (i.e. at micro level) (e.g., Ong and Lai, 2007; Ilias et al., 2009), or with all computer technologies available in the organization (i.e. at macro level) (e.g., Wixom and Todd, 2005; Landrum et al., 2010). The other direction is based on assessing the success of information systems based on satisfaction as a single comprehensive construct (e.g., Somers et al. 2003; Doll et al., 2004; Leclercq, 2007; Wang and Liao, 2007), or to incorporate it into the model as a construct with other constructs (e.g., DeLone and McLean, 1992; Kang and Lee, 2010).

Whether as a single dimension or with other dimensions, a considerable amount of research has adopted the user satisfaction approach to measure the success of a specific, or whole information system Table 2.5 summarizes selected studies that have adopted the user satisfaction approach.

Author(s)	Context/ Approach	Contribution / Results
Shin (2003)	Data warehousing / user satisfaction was considered as a single comprehensive variable for a specific data warehousing system	The effect of variables related to system quality, information quality, and service quality on user satisfaction for the data warehouse was studied. Results show that user satisfaction with the data warehouse was significantly affected by such system quality factors.
Doll et al. (2004)	Information systems / user satisfaction was considered as one comprehensive variable for the overall information system	Using a sample of 1166, researchers tested the end-user computing satisfaction instrument EUCS across four dimensions: respondent positions, types of application, hardware platforms, and modes of development. Results suggest that the meaning of user satisfaction is context sensitive and different across population subgroups.
Wixom and Todd (2005)	Information systems across different organizations /	Researchers integrated user satisfaction and technology acceptance model to understand information system usage. The study

	user satisfaction was one construct among other constructs for the overall information systems	incorporated information satisfaction and system satisfaction as two separate constructs. All relationships were found significant. The model explained 59% of the variance of intention use.
Sabherwal et al. (2006)	Information systems / user satisfaction was one construct for a specific information system	A model was developed to assess information system success. The model explained the relationships among four constructs representing the success of a specific information system (user satisfaction, system use, perceived usefulness, and system quality).
Ong and Lai (2007)	Knowledge management system KMS / user satisfaction was considered as a single comprehensive variable for a specific KMS	A model for assessing the satisfaction of employees toward a knowledge management system. Satisfaction of the knowledge management system model was constructed based on four aspects: content, ease of use, personalization, and community.
Pike et al. (2010)	Activity-based costing system (ABC) / user satisfaction was considered as one construct for different information systems	The study examined user perceptions of activity-based costing performance for three different types of system. Satisfaction with various ABC systems was tested on a survey of 54 developers and 181 users of 16 different systems to produce five performance constructs (cost accuracy, cost-benefit trade-off, ABC impact, information use, and decision action).

Table 2.5: Selected studies that adopted User Satisfaction in their evaluation of information systems

While the satisfaction literature offers valuable contributions to our understanding of information systems success and provides evidence for its potential predictive value of quality factors (e.g., information and system design factors), different conclusions have been drawn as to the applicability of this approach in predicting system success (Al-Maskari and Sanderson, 2010). In other words, user satisfaction tells only part of the story. For example, according to Goodhue (1986), Davis et al. (1989), and Wixom and Todd (2005), user satisfaction is a weak predictor of system usage. This was explained by Wixom and Todd (2005) since user beliefs about information systems are "poor predictors of behaviours" such as system usage. Additionally, there are other sound predictors (e.g. usefulness) which are consistent with the behaviour (usage) in terms of context and time. Researchers have emphasized that the satisfaction approach should be integrated alongside other factors, models and theories to fully examine the success of information systems from "design and system characteristics to the prediction and usage" (Wixom and Todd, 2005).

2.6.2 User Satisfaction Models in the Context of E-learning

User satisfaction in assessing the success of e-learning systems has also been utilized as a single comprehensive factor or alongside other factors. For example, a well-established model, with approximately 2000 citations, constructed by Sun et al. (2008), considered the six dimensions – learners, instructors, course, technology, design, and environment – as the critical dimensions affecting learners' satisfaction. Thirteen factors under these six dimensions were hypothesised. Among these, computer anxiety, instructor attitude towards e-learning, course quality, flexibility, perceived usefulness, perceived ease of use, and diversity in assessment gained empirical support. The results of the study show that improving users' satisfaction, through these factors, drives a successful e-learning system. Figure 2.18 depicts the model.

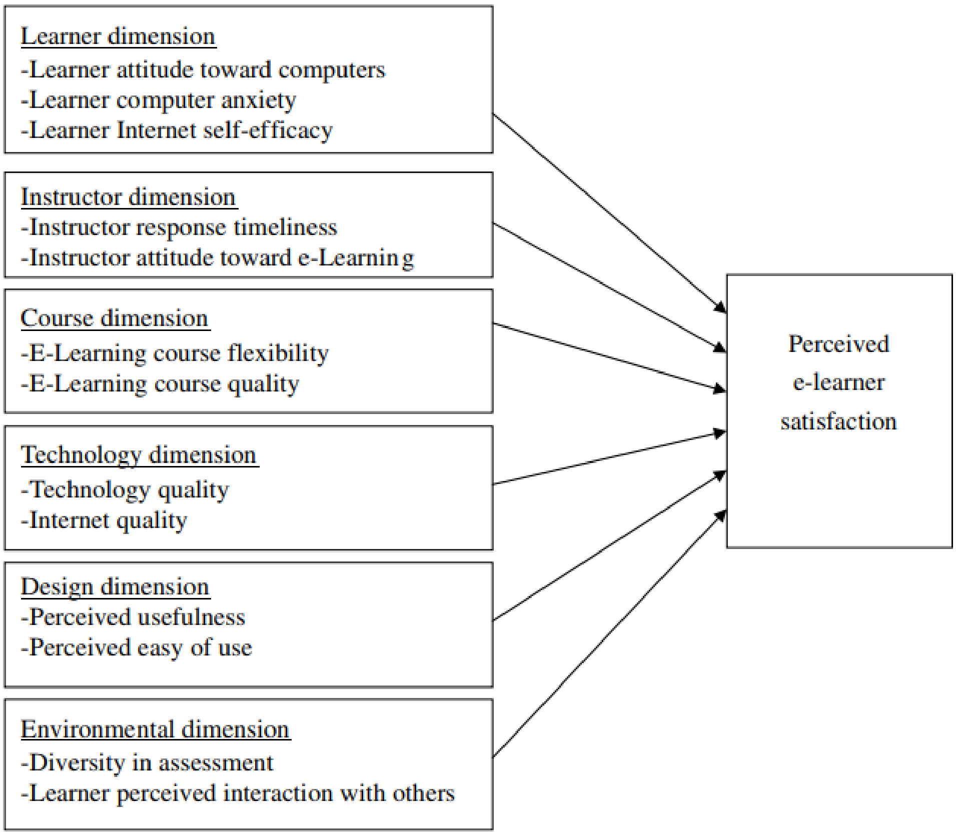


Figure 2.18: E-learning Success Model by Sun et al. (2008)

Another important contribution to e-learning success evaluation was the model proposed by Ozkan and Koseler (2009) (Figure 2.19). The researchers constructed a hexagonal model based on quality factors (system quality, information quality, and service quality) and social issues (supportive factors, learner perspective and instructor attitudes). The relationships between the six dimensions and e-learning satisfaction were found to be significant, and accounted for 76.9% of the variance of e-learning satisfaction. Researchers concluded that this model should be perceived as the basis for assessing the effectiveness of e-learning, and recommended extending the model with other dimensions.

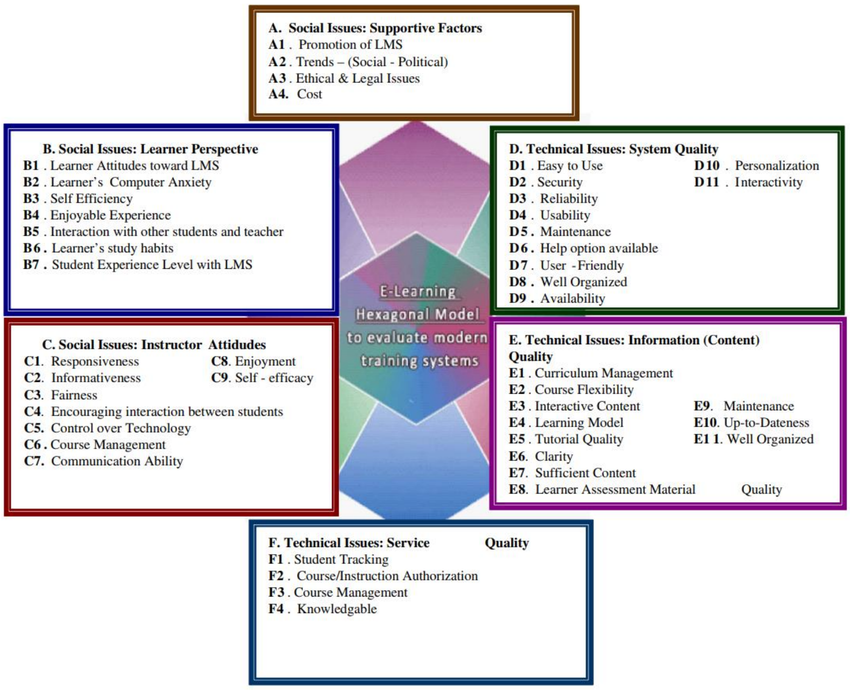


Figure 2.19: Hexagonal E-learning Assessment Model by Ozkan and Koseler (2009)

A study of blended e-learning system environments undertaken by Wu et al. (2010) introduced an e-learning satisfaction model (BELS), depicted in Figure 2.20. The model was tested with 212 participants. The findings of the study indicated that computer self-efficacy, performance expectations, system functionality, content features, interaction, and learning climate, are the primary determinants of student learning satisfaction with BELS. All relationships were found significant. The model explained 67.8% of the variance of learning satisfaction with BELS (Figure 2.20).

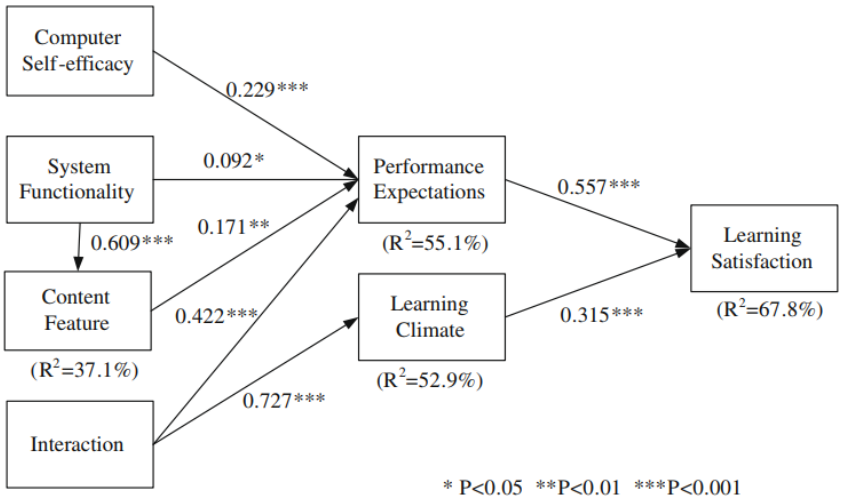


Figure 2.20: Learning Satisfaction Model (BELS) by Wu et al. (2010)

Another model was developed by Lee and Hwang (2007) to evaluate an e-learner's satisfaction with an LMS (Figure 2.21). Six constructs were assumed to influence satisfaction: information quality (IQ), service quality on interaction (ESQ), self-regulatory learning strategy (SRS), computer self-efficacy (CSE), perceived usefulness of the LMS (PU), and perceived ease of use of the LMS (PEOU). The model was empirically validated with 230 students. The results found that quality and self-regulated learning strategy based on computer self-efficacy are very important in the success of e-learning systems.

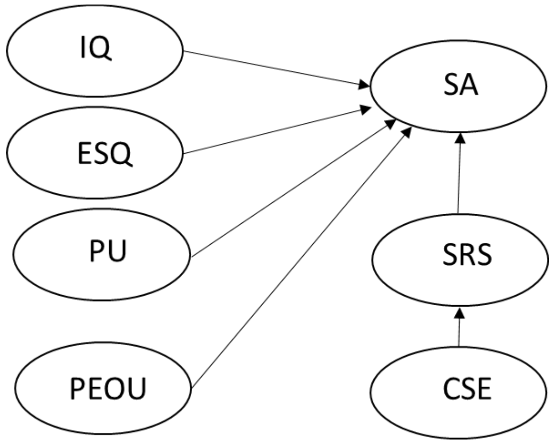
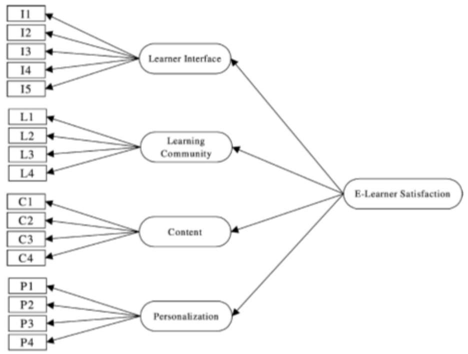
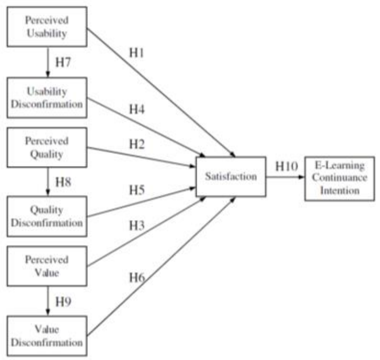
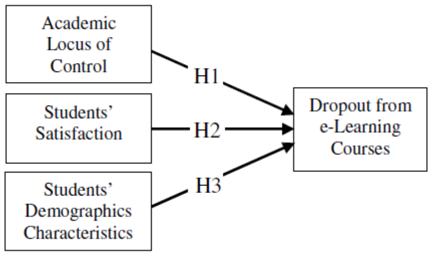
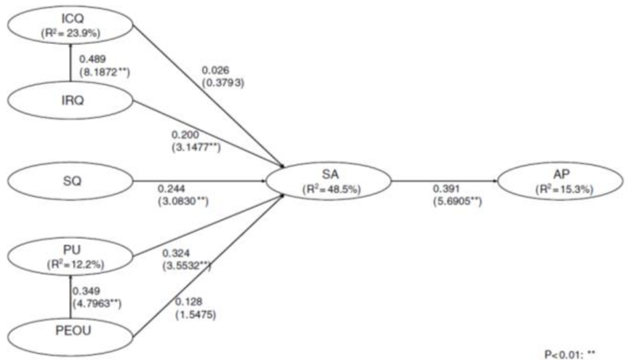
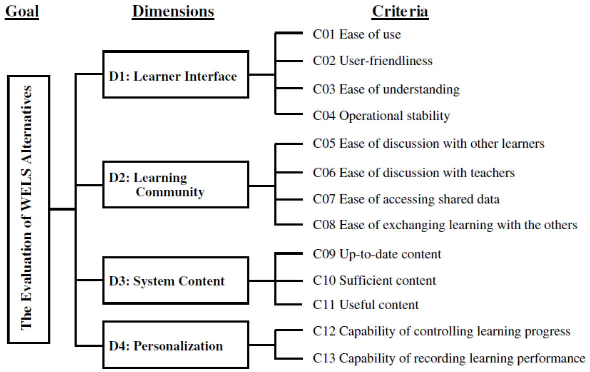
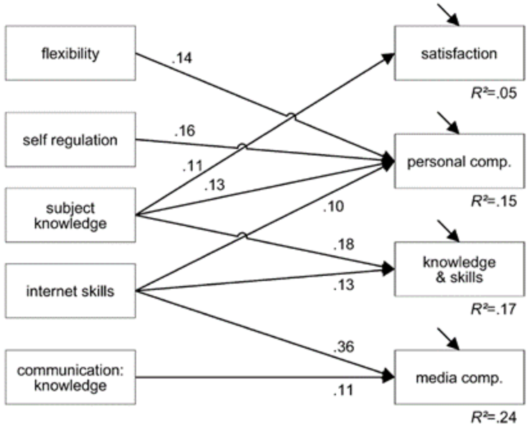


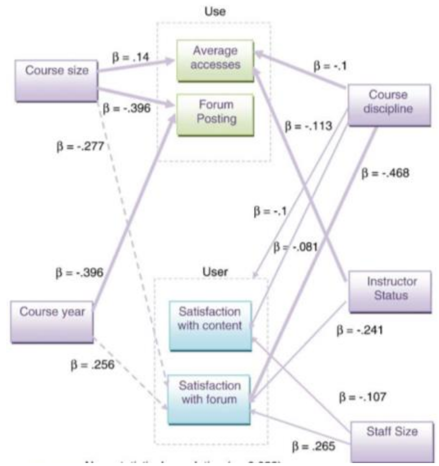
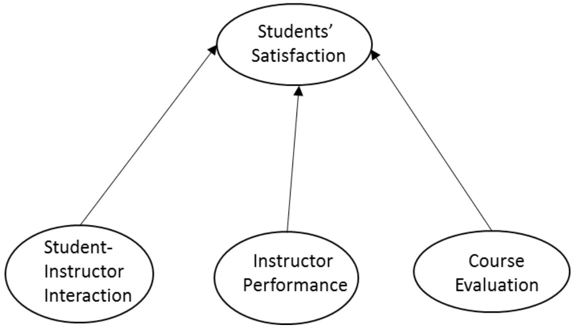
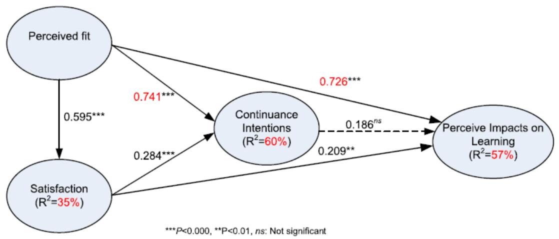
Figure 2.21: E-learning Satisfaction Model by Lee and Hwang (2007)

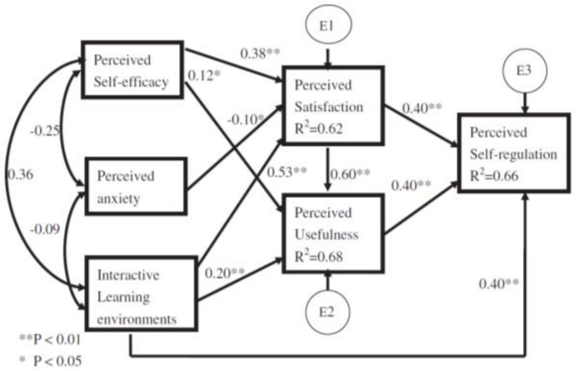
Researchers have shown that evaluation of an information system could not happen without assessing the feelings and perceptions of users who use it (Leclercq, 2007). Table 2.6 lists more studies that have adopted user satisfaction to evaluate different varieties of e-learning systems.

Author	System/ Sample	Model	Results/conclusion	Journal / Citation
Wang (2003)	Asynchronous e-learning systems, 116 respondents		A model developed for measuring the success of asynchronous e-learning systems. According to this model, satisfaction with an asynchronous e-learning system is caused by four variables: learner interface, learning community, content, and personalization.	Information & Management (741 citations)
Chiu et al. (2005)	E-learning system, 183 users		A model proposed to assess e-learning continuance intention. The model extended the expectancy disconfirmation theory EDT by decomposing the perceived performance component into usability, quality and value. Satisfaction was the main determinant of e-learning continuance. The model explained 68% of the variance of e-learning satisfaction and 48% of continuance intention.	Computers & Education (562 citations)
Levy (2007)	E-learning courses using WebCT, 372 students		The study explored two key constructs: academic locus of control and students' satisfaction with e-learning. Results of the study showed that lower satisfaction with e-learning courses was the key indicator in students' decision to drop out of the e-learning course. Also, the academic locus of control has no impact on students' decision to drop out from their e-learning courses.	Computers & Education (744 citations)

Liaw (2008)	Blackboard e-learning system, 424 students	-	A model developed to investigate students perceived satisfaction, behavioural intention and effectiveness of e-learning system. The results show that perceived self-efficacy is a critical factor that influences learners' satisfaction with the Blackboard. Perceived usefulness and perceived satisfaction both contribute to the learners' behavioural intention to use the e-learning system. Also, multimedia instruction, interactive learning activities, and e-learning system quality can influence e-learning effectiveness.	Computers & Education (830 citations)
Lee and Lee (2008)	Learning management system LMS, 225 students		A model proposed to assess the success of LMS. The model included the seven variables: academic performance AP; satisfaction SA, perceived usefulness PU, perceived ease of use PEOU, information contextual quality IQ, information representation quality IRQ, service quality SQ, and self-regulatory efficacy SRE. The model was empirically validated. Satisfaction was the determinant of academic performance and accounted for 15.3% of the variance of academic performance.	Computers in Human Behavior (261 citations)

Shee and Wang (2008)	Web-based e-learning system, 276 students		A model for evaluating the web-based e-learning system from the perspective of learner satisfaction was developed. Four dimensions were assumed to influence learner satisfaction: learner interface, learning community, system content, and personalization. Among these, learner interface was found the most important dimension and learning community was the least importance.	Computers & Education (371 citations)
Paechter et al. (2010)	E-learning systems, 2196 students from 29 universities in Austria		A model was developed to investigate students' expectations and experiences with e-learning systems in 29 universities in Austria. Four independent variables: flexibility, self-regulation, subject knowledge, internet skills, and communication were included in this model. The model explained only 5% of the variance of satisfaction; 15% of personal competence; 17% of knowledge and skills; and 24% of media competence.	Computers & Education (518 citations)

Naveh et al. (2010)	LMS, 8245 students		The study examined students' use and satisfaction with the LMS. Seven independent variables included in the model: course size, staff size, instructor status, course year, course discipline, content, existence of forums. The study revealed low significant correlation between use and satisfaction. Course content was found significantly correlated with use and satisfaction. LMS use was significantly influenced by course size, instructor status, and forum existence.	The Internet and Higher Education (153 citations)
Ali and Ahmad (2011)	Distance learning courses, 245 students		A model was developed to examine the relationship between student satisfaction and: instructors' performance, course evaluation, and student-instructor interaction. The three variables together explained 52% of the variation of the students' satisfaction.	Contemporary Education Technology (81 citations)
Lin (2012)	Virtual learning system VLS, 165 students		A model developed by integrating information systems continuance theory with task-technology fit TTF to understand the precedents of the intention to continue using VLS. The results revealed that satisfaction and perceived fit are important precedents of the intention to continue VLS and individual performance.	International Journal of Human Computer Studies (149 citations)

<table>
<tr>
<td>Liaw and Huang (2013)</td>
<td>E-learning systems, 196 students</td>
<td>
</td>
<td>The study investigated learner self-regulation in an e-learning environment. The results showed that perceived satisfaction, perceived usefulness, and interactive learning environments were predictors of perceived self-regulation. The three factors explained 66% of the variance of perceived self-regulation. Perceived self-efficacy and interactive learning environment accounted for 62% of the variance of perceived satisfaction. The same two variables explained 68% of perceived usefulness.</td>
<td>Computers & Education

(232 citations)</td>
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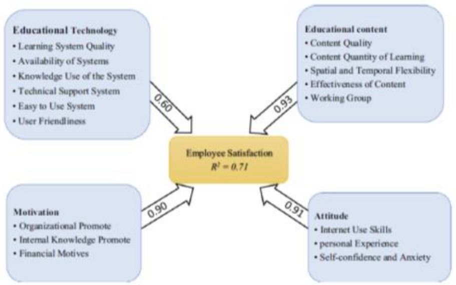
<td>Navimipour and Zareie (2015)</td>
<td>E-learning systems, 128 employees</td>
<td>
</td>
<td>A model proposed for assessing the impact of e-learning on employee's satisfaction. Four variables are found to be the determinants of employee satisfaction: educational technology, educational content, motivation, and attitude. The four variables together found significantly correlated with satisfaction. The amount of variance of employee satisfaction explained by the four variables was 71%.</td>
<td>Computers in Human Behavior

(97 citations)</td>
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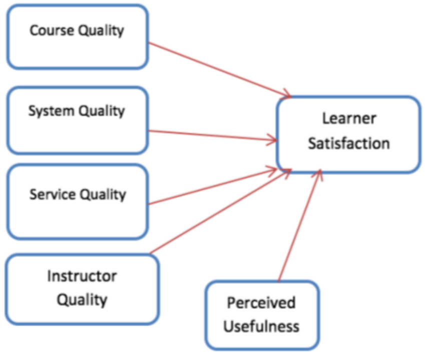
<td>Mtebe and Raphael (2018)</td>
<td>E-learning system, 153 students</td>
<td>
</td>
<td>A model developed to identify the factors that influence learners' satisfaction with the e-learning system at the University. The study found that system quality, instructor quality and service quality had a significant positive effect on learners' satisfaction. 34.3% of the variance of learner satisfaction was explained.</td>
<td>Australian Journal of Educational Technology (31 citations)</td>
</tr>
</table>

Table 2.6: Selected studies that adopted user satisfaction approach in their evaluation of e-learning systems

2.7 E-learning Success Based on E-Learning Quality Models

The fourth direction of research in evaluating e-learning systems is to assess the overall quality of e-learning. Though quality is a general term, different approaches and models emerged under this stream. Different aspects and approaches of quality were considered in e-learning quality models (e.g., excellence models, e-learning quality surveys, ISO 9000, and benchmarking).

An important model proposed by MacDonald et al. (2001) was the Demand-Driven Learning Model DDLM to evaluate web-based learning systems (WBL) (Figure 2.22). The model was developed in response to the need to design new learning models to meet users' needs. The model incorporated five dimensions. The first dimension is consumer demands (content, delivery, and service); the second dimension is the superior structural (i.e. the required foundation that makes it possible to provide this level of content, delivery and service) which requires an understanding of learners' needs; considering learner's motivation; learning facilitators to establish healthy collaborative learning environment; pedagogical strategies; conducting regular assessment strategies and evaluation of learners; and ensuring the e-learning environment is convenient for learners. The third dimension represents learner outcomes, e.g., lower cost for learner, personal advantages, and achieving learning outcomes. The fourth layer is the ongoing program evaluation, and the fifth is continuing adaption and improvement. The researchers stated that these constructs form the recipe where WBL programs can succeed. The model has been empirically validated and tested (MacDonald et al., 2005).

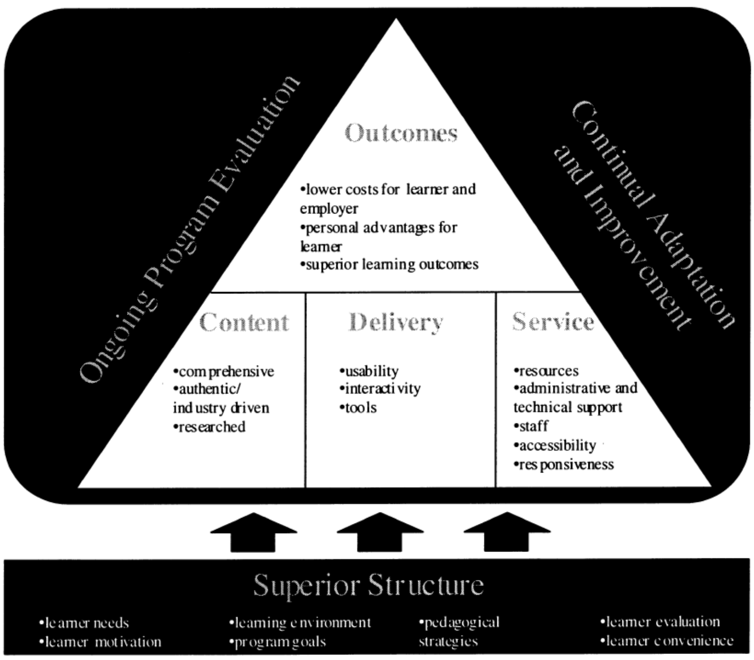


Figure 2.22: The Demand-Driven Learning Model DDLM by (MacDonald et al., 2001)

Another multi-dimensional model constructed by Ehlers (2003) was introduced to evaluate the quality of e-learning (Figure 2.23). Ehlers (2003) developed their model based on learners' perspectives, stressing the importance of understanding learners' needs before starting any e-learning project. According to this model, the quality of e-learning is a process of co-production between the learner and the learning environment to enable and empower the learner.

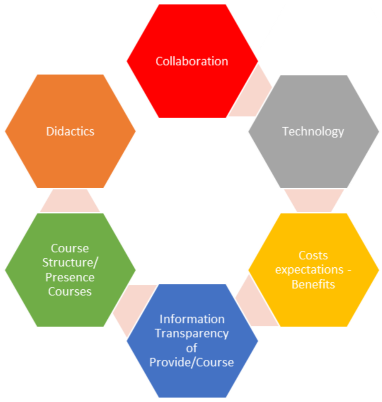


Figure 2.23: E-learning Quality Model (Ehlers, 2003)

Six dimensions were included in the model: course structure, technology, collaboration, didactics, cost benefits, and information transparency. In 2004, Ehlers introduced another model for assessing e-learning quality adding to the previous one: tutor support, and communication in the course (Ehlers, 2004). The model was updated in 2007 to identify four aspects of quality: experience, innovation, knowledge, and analysis (Ehlers, 2007).

There are large diverse approaches, models and frameworks in the literature. For example, Boud and Prosser (2002) assumed that higher e-learning quality can be measured by four aspects: learners' engagement; context acknowledgement; challenge for learners and the involvement of practice. Oliver (2005) studied quality assurance in e-learning, emphasising two main approaches: benchmarking and specification of standards. Benchmarking "compares the performance and outcomes in one setting against that achieved" whereas standards are the criteria used to judge performance.

Pawlowski (2007) proposed a quality adaptation model by comparing the approaches of e-learning quality with ISO/IEC. The same approach was adopted by Abdellatief et al. (2011), who proposed a quality model from the developer's perspective based on four variables: service content, system functionality, information technology, and system reliability.

A framework to evaluate the quality of e-learning by Ireland et al. (2009) focused on improving the skills of academics, and considered this the main stimulant of e-learning quality.

Another direction for assessing the quality of e-learning was by establishing agencies and programs to assure quality standards in e-learning, such as the Institute for Higher Education

Policy in the USA, the European Union e-learning program, and the Quality Assurance Agency QAA in England (Oliver, 2005). Further, in Europe, the quality of the e-learning survey was conducted to rate e-learning quality (Massy, 2002).

The study of Attwell (2006) identifies ten approaches for evaluating the quality of e-learning. Table 2.7 summarizes these approaches.

#	**Approaches**	**Example**
1.	Case studies of specific e-learning programmes	Descriptive evaluation reports
2.	Comparisons with traditional learning	Comparing e-learning effectiveness with traditional learning for specific instances of e-learning
3.	Tools and instruments for evaluation of e-learning	Devices to record and analyse usage by duration and frequency of log-in, pages accessed, user profile etc.
4.	Return on Investment (ROI) reports	Reports about the investment if it was cost-effective and represented value for money
5.	Benchmarking models	Criteria for quality standards of e-learning
6.	Product evaluation	Reports describing particular education software by the software developers
7.	Performance evaluation	Student assessment reports and surveys
8.	Handbooks for the evaluation of e-learning	Handbooks that provide feedback to influence e-learning implementation and future development
9.	Meta-studies	Studies attempting to answer the question of the effectiveness of e-learning by combining or bringing together the results of a series of different studies to provide a larger sample base
10.	Studies on the contribution of evaluation to metadata	Further studies developed based on meta data

Table 2.7: E-learning quality approaches by Attwell (2006)

Attwell (2006) developed a framework for e-learning evaluation based on five variables: learner variables, technology variables, environmental variables, contextual variables, and pedagogic variables.

Considerable amounts of research and effort have focused on the quality of e-learning. However, due to the complexity of e-learning systems, the diversity of e-learning stakeholders, and the generality of the 'quality' concept, there is uncertainty and ambiguity about what actually constitutes a quality e-learning approach (Oliver, 2005). Additionally, it becomes challenging to identify precise measurements suitable to evaluate e-learning systems based on quality approaches as the criteria vary from one organization to another.

2.8 Chapter Summary

An extensive review of the literature related to this research was given in this chapter. The chapter started by outlining definitions of e-learning success and evaluation, and an overview of e-learning systems in the context of this study was presented. The main part of this chapter is located in sections four to seven, summarising a total of 140 papers used to identify four approaches for evaluating the success of e-learning. The four approaches are the D&M success model, the TAM, satisfaction models, and e-learning quality models. The literature will be used in the following chapter to identify the main themes and sub-themes to develop our own study model.

CHAPTER THREE: MODEL DEVELOPMENT

3.1 Chapter Introduction

The previous chapter presented an intensive overview of prior studies that dealt with evaluating information systems and e-learning systems. Based on the four approaches presented in chapter 2, an initial conceptual model of the study was developed in section 2 of this chapter. The third section describes the factors and indicators of the initial conceptual research model. Finally, the formulation of the study hypotheses and the relations posited in the model and justification for each one is presented in section 4.

3.2 Development of Conceptual Model

In order to provide a general comprehensive definition of e-learning success measurements, the four approaches found for evaluating e-learning and information systems from the literature review are considered in developing our model: the DeLone and McLean information systems success model (D&M model), the Technology Acceptance Model (TAM); User Satisfaction Models; and E-learning Quality Models.

The approach followed for developing the model is similar to that adopted by DeLone and McLean, in which important aspects that represent the success of a whole system for a broad range of constructs are used, rather than focusing on a particular aspect of success (i.e., usage in TAM, and learner satisfaction in the user satisfaction model). Thus, different perspectives have been considered in developing our model, based on their great potential of evaluating the success of e-learning, in relation to: quality (system, information, service), social factors (support, learner and instructor), user beliefs (perceptions of satisfaction and usefulness), acceptance (actual usage or intention to use), and the benefits of using the e-learning system. These dimensions encompass the main components of the existing four approaches. The higher order themes resulting from analysing the literature are depicted in Figure 3.24. More details about the selection of the model constructs are given as follows.

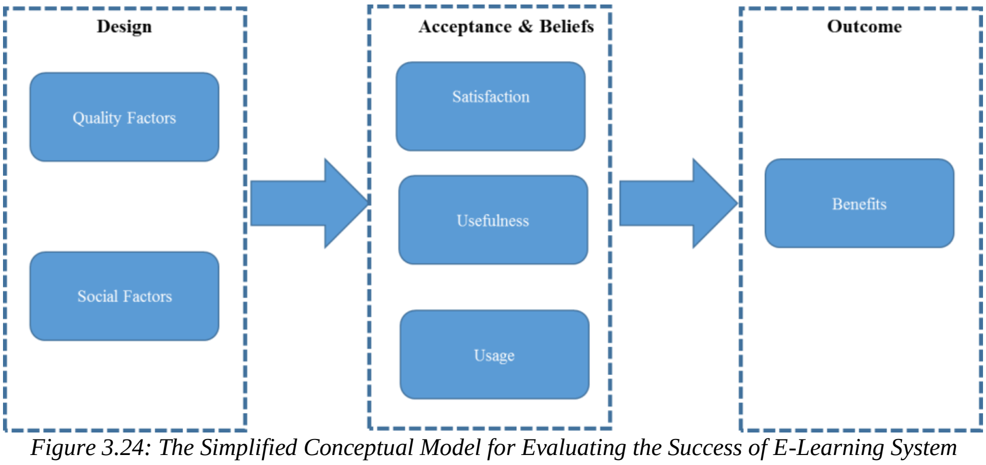


Figure 3.24: The Simplified Conceptual Model for Evaluating the Success of E-Learning System

Approach 1: DeLone and McLean Information Systems Success Model

The current study model mainly adopts the constructs of the D&M information systems success model and extends it to included constructs and indicators from other models and theories to fit the context of e-learning. The constructs adopted from this model are:

1. System Quality	2. Service Quality	3. Information Quality
4. Satisfaction	5. Use	6. Benefits

It is worth mentioning that the satisfaction construct is common between the D&M model and the satisfaction models, and use is common between the D&M model and TAM.

The D&M model was built to measure the success of information systems. Hence, a more customized version to conform to the needs of e-learning systems is taken into consideration to develop our model. System quality is an important determinant of the quality of e-learning; thus, it was integrated into our model but is broken down into three constructs:

1. Technical System Quality
2. Educational System Quality
3. Support System Quality

Technical system quality is related to issues like system reliability, availability, ease of using it, system features, etc. Conversely, educational system quality revolves around the existence of features like interactivity and communication components, assessment material, and diversity of learning styles. Support system quality corresponds to supportive issues in the e-learning system related to ethics and legal issues, and promotion of the e-learning system. More details about the definition of each construct and the indicators used to measure each one will follow.

On the other hand, measuring benefits, at both individual and organizational levels, is a key construct for assessing e-learning systems. However, measuring benefits at the organizational level requires "asking senior managers to assess the improved profitability" (Petter et al., 2008). Therefore, the current study does not focus on such benefits, and considers only the individual benefits for learners. The organizational benefits are beyond the scope of this study.

Approach 2: Technology Acceptance Model TAM

With respect to this approach, despite the plethora of TAM extensions, the two main constructs in this model are usefulness and ease of use (Abdullah and Ward, 2016). Usefulness has been included in our model from TAM, which was successfully integrated with the D&M model in the study of Seddon (1997). In his extended model, usefulness was considered to be a general perceptual measure of benefits and was operationalized as a determinant of user satisfaction. We integrated usefulness to our model, as introduced by Seddon (1997).

In contrast to TAM, ease of use was not operationalized as a separate construct in our model; rather, it is an aspect related to technical system quality. The effect of technical system quality, as a whole, on perceived satisfaction, perceived usefulness, and use, is expected to be greater than the effect of ease of use on the same three constructs. Therefore, ease of use was incorporated in our model as one of the indicators under the technical system quality construct.

Acceptance, in terms of intention to use or actual system use was also incorporated in our model. However, DeLone and McLean, in their updated model (2003), introduced intention to use as an alternative measure of use for some contexts, depending on the stage of using the system. Researchers have suggested that intention to use is a valid measure at an early stage of implementing a system. Since the e-learning system is in place in the context of the current study, it might be pointless to assess intention to use. Thus, assessing the actual system use is appropriate in our case, and was added to our model. In addition, the e-learning system in the context of the study is available for voluntary use; therefore, system use can act as a determinant for benefits from using the system. In other words, the benefits of the e-learning system cannot be achieved if learners do not use it (Seddon, 1997; Pituch and Lee, 2006; Lai et al., 2012; Alenezi and Karim, 2010; Abdullah and Ward, 2016).

The part of TAM referred to as 'attitude towards using' was included in our model as an indicator related to the quality of learner and instructor. Therefore, the learner's and instructor's attitudes toward using the system were incorporated as indicators under the two constructs: learner quality and instructor quality.

In a survey study conducted by Abdullah and Ward (2016), the researchers studied 107 papers that extended TAM in the context of e-learning. The results of the study showed that "Self-Efficacy, Subjective Norm, Enjoyment, Computer Anxiety, and Experience are the most commonly used external factors of TAM". Accordingly, the three indicators (self-efficacy, computer anxiety, and experience) were included in our model as indicators for capturing learner quality. Subjective norm was added under instructor quality. Enjoyment and pleasant experience were also incorporated under the perceived satisfaction construct.

Approach 3: User Satisfaction Models

As mentioned earlier in chapter 2, there are different strategies for assessing user satisfaction at the micro level (assessing satisfaction with a specific instance of the e-learning system) and at the macro level (assessing satisfaction with all technologies introduced by the organization in relation to e-learning). In our case, this study adopted satisfaction at a micro level to assess perceptions of users about a specific instance of e-learning. Enjoyable experience, satisfaction with system performance, satisfaction with providing education needs, and overall satisfaction are the indicators used in our model to represent this construct.

Among the e-learning satisfaction models, the model of Sun et al. (2008) and the model developed by Ozkan and Koseler (2009) provide potential contributions and good explanatory power for e-learning perceived satisfaction. From the two models, learner quality and instructor quality were added as two separate constructs in our model.

The learner quality construct is used to capture different aspects of quality related to learners, such as learner's attitude, anxiety, previous experience, and self-efficacy. Similarly, the instructor quality construct assesses the instructor's quality indicators, such as instructor's attitude, enthusiasm, prompt responsiveness to learners in the e-learning system, and communication with learners.

In Sun et al.'s model, the authors assumed an environmental dimension (with two indicators, diversity in assessment and interaction with others) as a determinant of satisfaction. This construct was renamed in our model as educational system quality, as discussed earlier in the D&M approach. Further, in Ozkan and Koseler's model, 'supportive factors' was introduced as a determinant of satisfaction, which was also included in our model as a separate construct, as mentioned earlier in the D&M approach.

Approach 4: E-learning Quality Models

No specific construct was added from e-learning quality models. However, some indicators were incorporated in our model from MacDonald et al.'s (2001), Attwell's (2006), and Ehlers' (2003) models: personalization, pedagogical strategies, learner needs, security, interactivity, cost expectations benefit, and learning outcomes.

Based on the results of previous studies, and according to the four approaches, we propose a more comprehensive multidimensional model for evaluating e-learning systems success (EESS model), a synthesis of the four previous approaches, depicted in Figure 3.25. The multidimensional model is comprehensive, and based not on the number of constructs but on the intention to provide a holistic picture and different levels of success related to a broad range of success determinants, rather than focusing on a specific construct.

Figure 3.25: Proposed Multidimensional Conceptual Model for Evaluating E-learning Systems Success (EESS model)

Why a comprehensive model is needed?

This research contributes to the growing body of e-learning systems success literature by providing a comprehensive multidimensional model which considers the main dimensions and sub-dimensions of the four approaches. A comprehensive model for evaluating e-learning system success is needed, for the following reasons.

- There is uncertainty and suspicion about what are actually the determinants of e-learning system success. Hence, this research, as a discrete activity, enumerates the literature related to information system success and e-learning system success, to distil factors that affect e-learning success evaluation.
- The D&M literature provides us with an explicit model for measuring information systems success, but it has to be broadened to include variables that fit the context of e-learning, enhance the explanatory power of the model, and focus on the very important role of human and social factors in the success of such systems. Further, DeLone and McLean did not empirically validate their model. Rather, the model was introduced as a framework for conceptualising information systems success dimensions. They recommended that other researchers further develop and validate the model in different contexts.
- In the same manner, TAM allows the acceptance and adoption of new technologies to be assessed, including e-learning systems; however, acceptance does not guarantee success, but limits our understanding to aspects related to behaviour, while there is a need to fully understand the whole picture of success. Over and above this, there is a need to consider all phases prior to using the system (e.g., system design, information quality).Also of importance are phases during the utilization of the system (e.g., usefulness and satisfaction), and after using the system (benefits of using the system).
- User satisfaction is an important predictor of success, but it should be integrated with other approaches to build a conceptual bridge between the different phases of the system, the better to examine the important role of satisfaction in influencing the learning benefits and assessing system success, and to maximize the predictive power of this construct.
- In relation to e-learning quality approaches, and given the diversity and complexity of e-learning systems, the spontaneity, ambiguity, and generality of some of these approaches, coupled with a lack of theoretical underpinning, make adopting this approach impractical and challenging to identify precise suitable measurements of success.

3.3 Components and Indicators of the Conceptual Model

A total of 11 constructs with 58 indicators were used to build our conceptual model. The literature was extensively studied, and the constructs and indicators rationally selected due to their relevance in evaluating e-learning systems. To the best of our knowledge, no study has combined all these measures in one single model. More details about each construct and indicators used to measure in our model, supported by literature from information and e-learning systems, are given in Table 3.8.

Constructs	Description	Indicators	Description	Related Studies
Technical System Quality (TSQ)	TSQ is concerned with the technical characteristics of the e-learning system and issues related to whether the e-learning system is easy to use, free of bugs, consistent, secure, and have the required functions.	Ease of use	The degree to which the user feels that using the e-learning system is free from efforts	Davis (1989); DeLone and McLean (2003); Sedara et al. (2004)
		Ease to learn	The degree to which the user feels that the e-learning system is easy to comprehend and learn	DeLone and McLean (2003); Sedara et al. (2004)
		User requirements	The degree to which the e-learning system meets the requirements of users	Sedara et al. (2004)
		System features	The existence of the necessary functions and features in the e-learning system	Sedara et al. (2004)
		System availability	The availability of the e-learning system to perform learning activities	DeLone and McLean (2003)
		Flexibility	Flexibility in interacting with the system's interface	Selim (2003); Sedara et al. (2004)
		Integration	The integration and consistency between the different components of the system	Selim (2003); Sedara et al. (2004)
		System reliability	The probability that the e-learning system will provide the learning tasks at the specified time	DeLone and McLean (2003); Sedara et al. (2004)
		Fulfilment	The probability that the e-learning system will offer the services free of bugs	Sedara et al. (2004)
		Security	The capability of the e-learning system to maintain secure navigation and protection of users' information	Holsapple and LeePost (2006)
		Personalization	Providing a personalized e-learning system that directly contributes to a student's learning	DeLone and McLean (2003); Ozkan and Koseler (2009)
Information Quality (INQ)	INQ is concerned with the desired characteristics required by the user in relation to the content and information in the e-learning system such as clarity, up to date, and sufficiency of information.	Sufficiency	Providing sufficient and required information	DeLone and McLean (2003)
		Accessibility	Accessibility of the resources and information needed at the specified time	Selim (2003); Ozkan and Koseler (2009)
		Usability	Providing information in the e-learning system in an appropriate format that is readily usable by users	Sedara and Gable (2004); Ozkan and Koseler (2009)
		Conciseness	Providing concise and clear information	Sedara et al. (2004)
		Understandability	Organizing the information into logical and understandable components in the e-learning system	Sedara et al. (2004); Selim (2003)
		Up to date content	Providing recent and up to date content in the e-learning system	Ozkan and Koseler (2009)
		Content design quality	Providing pleasant design of the e-learning system that meets quality standards to users	Roca et al. (2006)

Service Quality (SRQ)	SRQ is concerned with the overall support delivered by IT services personnel to the users	Providing guidance services	Providing training and clear instructions to direct users on using the e-learning system	Chang and King (2005); Hassanzadeh et al. (2012)
		Providing help	Providing online assistance and help in the e-learning system	Holsapple and LeePost (2006); Ozkan and Koseler (2009)
		Staff availability	The availability of IT services staff when users face a problem with the system	Holsapple and LeePost (2006)
		Fair understanding	Knowledgeable personnel who have fair understanding of specific learners' needs	DeLone and McLean (2003); Holsapple and LeePost (2006)
		Responsiveness	Timely responsive from IT services personnel	DeLone and McLean (2003)
Educational System Quality (ESQ)	ESQ is concerned with the features of the e-learning system that facilitate and improve a conductive learning environment	Interactivity components	The existence of communication and interactivity components in the e-learning system, e.g., quizzes, discussion forums	Selim (2003); Sun et al. (2008); Hassanzadeh et al. (2012)
		Diversity of learning styles	Using different learning styles (e.g., video, audio, text, images) to meet learners' different learning styles	Selim (2003); Sun et al. (2008); Hassanzadeh et al. (2012)
		Assessment materials	The existence of evaluation and assessment materials in the e-learning system, e.g., quizzes	Selim (2003); Sun et al. (2008); Hassanzadeh et al. (2012)
Support System Quality (SUP)	SUP is concerned with supportive aspects of the e-learning system that have an influence on users	Ethical issues	Providing information about plagiarism when submitting assignments, and copyright laws for materials in the e-learning system.	Khan (2005), Ozkan and Koseler (2009)
		Legal issues	Providing sufficient information about behavioural considerations when communicating in the e-learning system	Khan (2005), Ozkan and Koseler (2009)
		Promotion of the e-learning system	The popularity and the promotion of the e-learning system	Ozkan and Koseler (2009)
Learner Quality (LER)	LER is concerned with the quality of the learner in different aspects which influence their utilization of the e-learning system	Learner's behaviour toward using the e-learning system	The degree to which learners believe it would be helpful to use the e-learning system	Davis (1989)
		Learner's attitude	Learner's attitudes toward utilizing technology for their learning	Sun et al. (2008)
		Learner's anxiety	Fears of technology usage resulted from mental pressure	Piccoli et al. (2001); Sun et al. (2008)

		Learner's previous experience	Learner's past experiences and familiarity with e-learning	Ozkan and Koseler (2009); Selim (2007)
		Learner's self-efficacy	Learner's judgments of their capability to successfully perform the required tasks in the e-learning system	Roca et al. (2006); Sun et al. (2008)
Instructor Quality (INS)	INS is concerned with the quality of the instructor in different aspects which are important for effective utilization of the e-learning system	Subjective norm	It is related to how the opinion from the instructor may influence student's tendency to use the e-learning system	Roca et al. (2006)
		Instructor's enthusiasm	Instructors' interest and motivation in using e-learning systems for delivering learning activities	Sun et al. (2008)
		Instructor's responsiveness	Instructor's prompt responsiveness to questions raised in the discussion forum and other interactivity tools in the e-learning system	Sun et al. (2008); Ozkan and Koseler (2009)
		Instructor's interactive communication	Instructor's effective and interactive communication with learners in the e-learning system	Sun et al. (2008); Ozkan and Koseler (2009)
		Instructor's attitude	Instructor's attitude toward utilizing technology for learning	Sun et al. (2008); Lee et al. (2009)
Perceived Satisfaction (SAT)	SAT is concerned with the user's level of satisfaction when utilizing the e-learning system	Satisfaction with system performance	The degree to which learners are satisfied with the performance of the e-learning system	Arbaugh (2000); Hassanzadeh et al. (2012)
		Enjoyable experience	The degree to which learners feel they have an enjoyable experience when using the e-learning system	Arbaugh (2000)
		Providing educational needs	The degree to which learners are satisfied with the system due to it providing (for) their educational needs	Hassanzadeh et al. (2012)
		Overall satisfaction	The degree to which learners overall are satisfied with the e-learning system	Cidral et al. (2018)
Perceived Usefulness (USF)	USF is a perceptual measure of the degree to which users believe that using the e-learning system would enhance their learning performance	Accomplish tasks quickly	The degree to which learners feel that using the e-learning system enables them to accomplish tasks more quickly	Venkatesh and Davis (2000); Selim (2003); Pituch and Lee (2006); Rai et al. (2002)
		Improving learning performance	The degree to which learners feel that using the e-learning system improves their performance	Selim (2003); Rai et al. (2002); Roca et al. (2006)
		Effective learning	The degree to which learners feel that using the e-learning system enhances the effectiveness of their learning	Venkatesh and Davis (2000) Selim (2003); Pituch and Lee (2006); Roca et al. (2006)
		Overall usefulness	The degree to which learners feel that the e-learning system overall is useful to them	Selim (2003); Roca et al. (2006)

Use (USE)	USE is a measure of the actual usage of the e-learning system, which is the degree to which the user is dependent on the e-learning system for the execution of learning tasks	Frequency of use	Number of accesses of the e-learning system	DeLone and McLean (2003); Selim (2003)
		Dependence on system	Dependency on the e-learning system	Rai et al. (2002); DeLone and McLean (2003); Selim (2003)
		Regular use	Usage pattern of the e-learning system	DeLone and McLean (2003); Selim (2003)
		Duration of use	Time using the e-learning system	DeLone and McLean (2003); Selim (2003)
Benefits (BNT)	BNT is concerned with student's perceptions of the expected general benefits (overall individual impacts) resulted from using the e-learning system	Increasing knowledge	The degree to which a student believes that utilizing the e-learning system has increased their knowledge and helped them to be successful in the course	Hassanzadeh et al. (2012)
		Improving learning process	The degree to which a student believes that utilizing the e-learning system has improved their learning performance	Rai et al. (2002); Holsapple and LeePost (2006); Hassanzadeh et al. (2012)
		Easier interaction and communication	The degree to which a student believes that utilizing the e-learning system has made the communication easier with other students and with the instructor	Selim (2003); Almutairi and Subramanian (2005)
		Time and cost saving	The degree to which a student believes that utilizing the e-learning system has reduced the time taken to complete learning tasks and search for materials, and saving other related costs	DeLone and McLean (2003); Holsapple and LeePost (2006); Hassanzadeh et al. (2012)
		Achieving learning goals	The degree to which a student believes that utilizing the e-learning has helped them to achieve the learning goals of the course	Selim (2003); Hassanzadeh et al. (2012)

Table 3.8: Description of the constructs and indicators of the EESS model

3.4 Hypotheses Development

The hypotheses about the connections in the research model with the corresponding discussions are presented in this section. Each relationship between the constructs of the model is justified based on the assumptions proved in the literature of e-learning and information systems success.

The research adopts the positivism paradigm as discussed later in chapter 4. This paradigm is based on pre-fixed connections found in related literature. As a result, this study assumes that the potential relationships between the constructs of the model are positively significant, as confirmed in previous studies. The hypotheses about the relationships are as follows.

1. Technical System Quality (TSQ)

In our model, technical system quality is assumed to determine three constructs: perceived usefulness, perceived satisfaction, and use. In the original model of DeLone and McLean (2003) the researchers assumed that system quality directly affects use and user satisfaction. Several researchers applied the DeLone and McLean's model in the information systems context and found a positive association between system quality and use (Iivari, 2005; Halawi et al., 2007; Hsieh and Wang, 2007).

In the e-learning systems context, system quality was also shown to be strongly related to use Balaban et al., 2013; Garcia-Smith and Effken, 2013; Marjanovic et al., 2016).

Other researchers have studied the relationship between system quality and user satisfaction, and have shown the existence of positive relationships between the two (Wu and Wang, 2006; Chiu et al. 2007; Halawi et al., 2008; Hsieh and Wang, 2007; Leclercq, 2007). Hassanzadeh et al. (2012) assumed that "whatever the technical quality of e-learning systems is more, user satisfaction is higher" and proved this claim.

In terms of relationship with usefulness, Seddon and Kiew (1994) and Seddon (1997) in their studies showed that "increases in system quality will cause increase in usefulness" (Seddon and Kiew, 1994) and found that system quality is an essential determinant of usefulness. Similar findings were obtained by Sabherwal et al. (2006) and Liaw (2008).

Based on these findings, we therefore assume that the higher the technical quality of the e-learning system, the more satisfied users are. Users will also find the e-learning system compatible with their requirements and this would positively make users utilize it and consider it useful. Thus, the following hypotheses are proposed.

H1a: Technical System Quality positively influences the perceived satisfaction with the e-learning system

H1b: Technical System Quality positively influences the perceived usefulness of the e-learning system

H1c: Technical System Quality positively influences the use of the e-learning system

2. Information Quality (INQ)

Information quality is a key, indispensable dimension in evaluating the success of information and e-learning systems due to the essential role of information in achieving learning goals and the serious problems resulted from poor quality of information (Al-Sabawy, 2013). The relationship between INQ and both use and user satisfaction came from the DeLone and McLean's (2003) model.

Based on the information systems literature, Rai et al. (2002) showed that there is a significant relationship between information quality and use. The same result was obtained by the studies conducted by Halawi et al. (2008) for knowledge management systems and Kositanurit et al. (2006) in health information systems.

In the same context, Seddon and Kiew (1994) and Seddon (1997) showed a significant relationship between information quality and perceived usefulness and user satisfaction.

The relationships between information quality and each of the three constructs – use, satisfaction, and usefulness – have been studied and empirically shown by e-learning researchers. For example, Klobas and McGill (2010) and Eom et al. (2012) found a significant relationship between information quality and both use and satisfaction with LMS. The relationship between information quality and perceived usefulness was found to be significant in the study of Chen (2010) with e-learning systems in an organizational context, and a similar result was found by Lwoga (2014) with web-based LMS. Therefore, we may assume that the quality of information in the e-learning system will positively lead to an increase in perceived usefulness and perceived satisfaction and system usage. We hypothesise the following.

H2a: Information Quality positively influences the perceived satisfaction with the e-learning system

H2b: Information Quality positively influences the perceived usefulness of the e-learning system

H2c: Information Quality positively influences the use of the e-learning system

3. Service Quality (SRQ)

This construct was new to the DeLone and McLean model (1992). The importance of this construct as a measure of information systems success is related to the DeLone and McLean model (2003) which assumed direct relationships between service quality and both use and user satisfaction. Delivering services by IT personnel in the organization, whether related to an information system or to an e-learning system, is also expected to be of great use to learners and to positively influence their perceptions of satisfaction with the system.

The construct has been utilized in the information systems field. For example, the relationship between SRQ and satisfaction was confirmed by Chen and Cheng (2009) in an online shopping system. The direct relationship between SRQ and use was found significant by Wang and Liao (2008) in an e-government system.

Similarly, in the context of e-learning, the relationship between SRQ and satisfaction was found significant in the Roca et al. (2006) and Ozkan and Koseler (2009) models. The relationship between SRQ and perceived usefulness proposed in the conceptual models was developed by Lwoga (2014) and Hagos et al. (2016) and was shown empirically to be significant in the studies conducted by Ngai et al. (2007) and Al-Sabawy (2013).

Accordingly, the following hypotheses are proposed.

H3a: Service Quality positively influences the perceived satisfaction with the e-learning system

H3b: Service Quality positively influences the perceived usefulness of the e-learning system

H3c: Service Quality positively influences the use of the e-learning system

4. Educational System Quality (ESQ)

In developing a model for measuring the success of e-learning in Iranian universities, Hassanzadeh et al. (2012) found that the quality of educational systems positively and directly influences user satisfaction, and indirectly, the use of the system, which indicates educational features in the e-learning system, and facilities like discussion forums, chat-rooms, collaborative learning tools, etc., can result in user satisfaction and a maximizing of their use of the e-learning systems. The relationship between educational system quality and perceived usefulness was found to be significant for web-based e-learning systems in the study undertaken by Liu et al. (2005) and by Almaiah and Jalil (2016) for mobile learning systems. Kim et al. (2012) and Mohammadi (2015) found a positive relationship between educational system quality and satisfaction. In addition, the relationships between diversity in assessment materials, and learner interaction in the e-learning system with perceived satisfaction, were found to be significant by Cidral et al. (2018). Further, the relationship between educational system features and usefulness was found significant by Liu et al (2005) for a web-based e-learning system. The same results were obtained by Liaw and Huang (2013) where a significant relationship between interactive learning environment construct with both perceived usefulness and perceived satisfaction was found.

Therefore, the following hypotheses about educational system quality are proposed.

H4a: Educational System Quality positively influences the perceived satisfaction with the e-learning system

H4b: Educational System Quality positively influences the perceived usefulness of the e-learning system

H4c: Educational System Quality positively influences the use of the e-learning system

5. Support System Quality (SUP)

In the literature relating to e-learning success and evaluation, supportive issues in the e-learning system include ethics and policies that outline rules, regulations, guidelines and prohibitions on communicating within the e-learning system, assignments' plagiarism rules, data protection, and other legal and copyright issues of the uploaded materials in the e-learning system, in addition to the popularity and policy followed by the organization. All these issues influence the learners significantly (Khan, 2005). For example, in regards to the empirical study conducted by Ozkan and Koseler (2009), the use of the LMS at the Brunel University has increased significantly due to the encouragement students and academics received from the university to use the LMS in their modules. The researchers stated that "the use of U-Link has increased significantly during the last three years… this is mainly because of the increasing popularity of e-learning portals." The researchers studied the relationship between supportive system issues and satisfaction, and found it significant. On the other hand, the organizational promotion of the e-learning system significantly and positively affected employees' satisfaction in the study conducted by Navimipour and Zareie (2015).

The relationships between support system quality and both perceived usefulness and use, have not been empirically tested in the prior literature. However, we argue that the existence of supportive issues in the e-learning system is also expected to positively influence the use of e-learning systems and perceptions of usefulness. This is because more attention has been given recently to ethical and legal issues, and new requirements have been introduced for data protection legislation. Further, considering the existence of communication facilities (e.g., forums, chat, and email), data generated from chat and forums may express personal opinions, personal data and personal biases that students are unlikely to want the outside world (through search engines) to know. Thus, providing information prior to using the e-learning system can increase their awareness and significantly influence their perceptions of the overall usefulness of the system.

Moreover, the popularity of the e-learning system, and the policy followed by the organization to promote their e-learning system play an important role in increasing the use of the system by academics and learners. Therefore, we propose the following hypotheses.

H5a: Support System Quality positively influences the perceived satisfaction with the e-learning system

H5b: Support System Quality positively influences the perceived usefulness of the e-learning system

H5c: Support System Quality positively influences the use of the e-learning system

6. Learner Quality (LER)

This construct was successfully operated in several models developed by prior e-learning researchers. Several researchers examined a subset of the learner quality construct: for example, the learner's self-efficacy was studied by Ong et al. (2004) and a significant relationship with perceived usefulness was found. The same result was achieved by Park (2009). McGill and Klobas (2009) studied the relationship between the learner's attitude toward LMS use and LMS utilization, and found it significant. Additionally, the relationships between student involvement and both use and satisfaction were significant (Klobas and McGill, 2010). Also, the relationships between self-efficacy and learner's computer anxiety with perceived usefulness were empirically studied by Chen and Tseng (2012). However, the changing role of learners in recent e-learning systems has made the quality of learner an independent construct (Sun et al, 2008).

The relationship between learner and perceived satisfaction was found to be explicitly significant in the models of Sun et al. (2008) and Ozkan and Koseler (2009). Given the positive relationships between the indicators associated with the variety of learner's characteristics, it is more likely that the quality of the learner will influence perceived usefulness and use of the system. Thus, we propose the following hypotheses.

H6a: Learner's Quality positively influences the perceived satisfaction with the e-learning system

H6b: Learner's Quality positively influences the perceived usefulness of the e-learning system

H6c: Learner's Quality positively influences the use of the e-learning system

7. Instructor Quality (INS)

The instructor's role in the success of e-learning has received attention from researchers in the e-learning arena. To clarify, the model developed by Sun et al. (2008) researched the relationship between the instructor dimension, using two indicators (instructor response timeliness, instructor attitude toward e-learning), and satisfaction, and found it positively significant. Similar results were obtained by Cidral et al. (2018), who found a positive relationship between instructor attitude toward e-learning and user perceived satisfaction.

Lwoga (2014) employed instructor quality as a separate construct and confirmed a positive significant relationship between instructor quality and both perceived usefulness and user satisfaction. Also, instructor quality has been found to have a significant effect on learners' satisfaction with an e-learning system in the study conducted by Mtebe and Raphael (2018). Subjective norm as an indicator related to instructor quality was studied in the models developed by Roca et al. (2006) and Park (2009) and significant relationships with usefulness and satisfaction were found respectively.

Little research has been found to investigate the relationship between instructor quality as a standalone construct and e-learning system use. In our research, we assume that aspects related to instructors, such as positive attitude, enthusiasm, recommendation to students, involvement with different levels of activities (e.g., interactive and communication and responsiveness to students) are also likely to influence utilizing the e-learning system. Nevertheless, McGill and Klobas (2009) studied the correlation between instructor norms and LMS utilization and found it positively significant. Based on this, we propose the following hypotheses.

H7a: Instructor's quality positively influences the perceived satisfaction with the e-learning system

H7b: Instructor's quality positively influences the perceived usefulness of the e-learning system

H7c: Instructor's quality positively influences the use of the e-learning system

8. Perceived Satisfaction (SAT)

There is no doubt that satisfaction has been seen as having high validity and reliability, and is an essential measurement of the success of both information systems and e-learning systems. In our study model, we assume that user satisfaction is a determinant of benefits construct. The influence of user satisfaction on the benefits achieved from the system was proposed in the DeLone and McLean information systems success model (2003). Hassanzadeh et al. (2012) explained that when users of the e-learning system are more satisfied, they are using the system, and the benefits of using the system will be achieved. Cidral et al. (2018) found that perceived satisfaction explained 43.3% of the variance of individual impacts, denoting a significant relationship between the two. The same results were obtained by Eom et al. (2012) and Hassanzadeh et al. (2012). Therefore, we assume the following hypothesis.

H8: Perceived Satisfaction with the e-learning system positively influences students' benefits

9. Perceived Usefulness (USF)

Usefulness was used by Davis et al. (1989) as a key determinant construct in the Technology Acceptance Model. Acceptance is a necessary element for measuring the success of information and e-learning systems (Davis et al., 1989; Roca et al., 2006).

The model of the study anticipates that the perceived usefulness of e-learning could positively influence three constructs: perceived satisfaction, use, and students' benefits. The findings from the literature empirically support these relations. In Arbaugh's (2000) study, it was hypothesized that "Perceived usefulness of the course software will be positively associated with student satisfaction with an Internet-based course", and this hypothesis was supported. Likewise, the studies of Seddon (1997) in information system success, Al-Sabawy (2013) in e-learning systems success, and Limayem and Cheung (2008) all found that perceived usefulness significantly and directly affects user satisfaction.

Correspondingly, if students perceive that the e-learning system is useful to them, they are more likely to use it. This relationship has been assessed in various e-learning studies, for example, Pituch and Lee (2006); VanRaaij and Schepers (2008); Šumak et al. (2011); Islam (2012a); Islam (2013); Sandjojo and Wahyuningrum (2015).

Previous studies have highlighted the direct significant relationship between usefulness and net benefits (Hwang et al., 2008); usefulness and organizational benefit (Park et al., 2011); usefulness and individual impact (Lee et al., 2011); usefulness and both individual and organization impact (Hasan et al., 2017). We therefore propose the following hypotheses.

H9a: Perceived Usefulness positively influences the perceived satisfaction with the e-learning system

H9b: Perceived Usefulness positively influences the use of the e-learning system

H9c: Perceived Usefulness positively influences students' benefits

10. System Use (USE)

Actual system usage is a common measure between the IS success model of DeLone and McLean (2003) and the TAM of Davis et al. (1989). In the systematic literature review study conducted by Petter et al. (2008), it was reported that 'use' has a moderate association with benefits of using the system. Through prior studies, the relationships between the use and the benefits of the system were found significant (Chen, 2012; Hou, 2012; Garcia-Smith and Effken, 2013). At an organizational level, the use of e-learning systems to deliver training courses for employees were proved to directly and positively affect the net benefits of the company (Chen, 2012). Other series of studies found similar results (Zhu and Kraemer, 2005; Kositanurit et al., 2006; Halawi et al., 2008). Accordingly, we expect that using the system can positively enhance students' benefits, such as increasing knowledge, saving time, and managing the learning process systematically. Given support from prior research, the current study proposes the following hypothesis:

H10: The use of the e-learning system positively influences students' benefits

To summarize, Table 3.9 shows the relationships proposed in this section that are to be examined in the context of the model.

Constructs	Perceived Satisfaction	Perceived Usefulness	Use	Benefits
Technical System Quality	→	→	→	
Information Quality	→	→	→	
Service Quality	→	→	→	
Educational System Quality	→	→	→	
Support	→	→	→	
Learner Quality	→	→	→	
Instructors Quality	→	→	→	
Perceived Satisfaction				→
Perceived Usefulness	→		→	→
Use				→

Table 3.9: Proposed relationships in the study model

Based on the literature and the above relationships, the components of the model were linked so as to reflect the hypotheses and show the directions of the assumed relationships. Figure 3.26 depicts the EESS model.

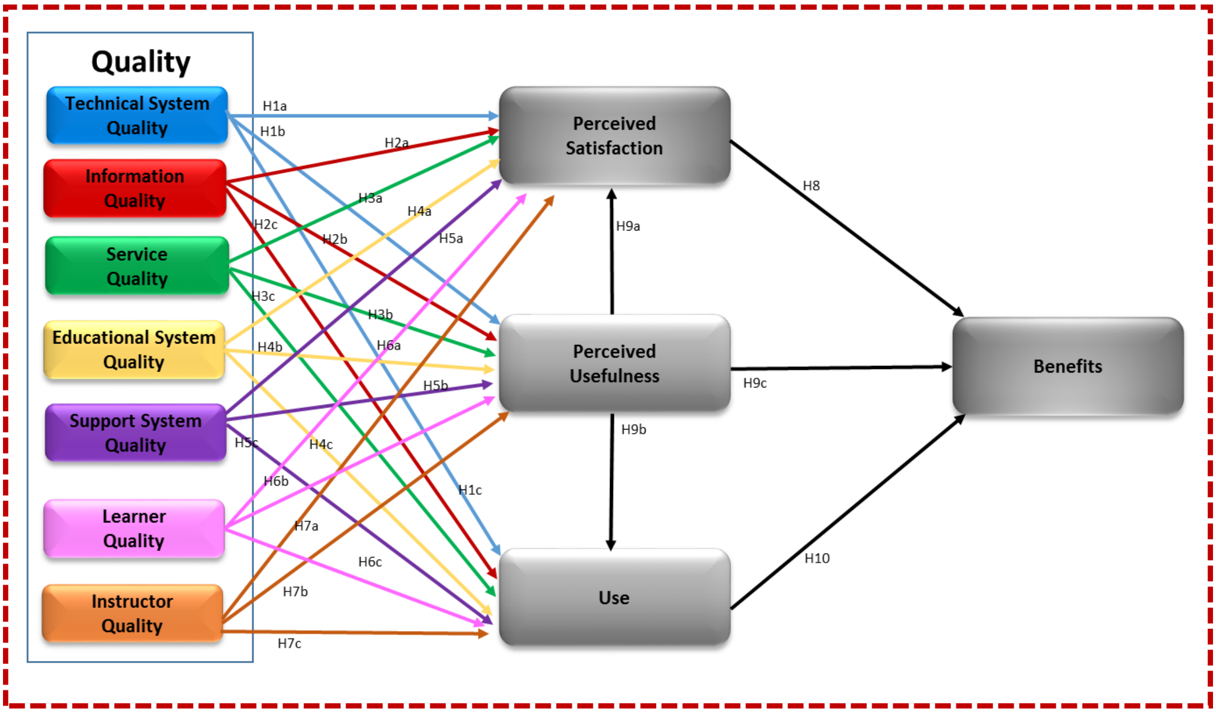


Figure 3.26: Evaluating E-learning Systems Success (EESS) Model

3.5 Chapter Summary

This chapter introduced the proposed model for evaluating the e-learning systems success (EESS) model. The constructs of the model and the indicators used to capture each construct were distilled from the four approaches found in the literature. The definitions of these measures were given one after another, supported by related studies. The relationships between the constructs were hypothesized. Theoretical justification for each hypothesis was also given in this chapter.

CHAPTER FOUR: RESEARCH METHOLDOGY

4.1 Chapter Introduction

Chapter 4 describes the overall research approach and research methodology. Section 2 describes the philosophy of the research. The research approach follows in section 3, including the research methods and justification for employing them. Research methods are presented in section 4. The selection of the data collection method is illustrated in section 5. Section 6 demonstrates the research context, population and sampling technique for this study. Section 7 is dedicated to the instrument administration and validity of the instrument. Details about data collection and response rates are given in section 8. Finally, the model testing approach is briefly described.

4.2 Research Paradigm

A research paradigm or philosophy is related to the kind of knowledge upon which the research is premised. Paradigms are crucial in guiding how to make decisions and conduct the research (Guba, 1990). The two paradigm schools that govern the information systems research discipline are positivism and interpretivism (or constructivism). According to Orlikowski and Baroudi (1991), research is positivist if 1) there is a unique description of the phenomenon, 2) the researcher and phenomenon of investigation are independent, 3) research is premised on priori fixed relationships within the phenomena, 4) research can be described by quantifiable, measurable properties, 5) there exist unidirectional cause-effect relationships that are capable of being identified and tested via hypothetic-deductive logic and analysis, and 6) conclusions about the phenomena can be drawn from the particular study sample. In contrast, interpretive research is conducted by means of qualitative methods, when little is known about reality to exploring the phenomena of interest; there are multiple interpretations of reality based on the researcher (each researcher constructs their own reality) and research participants; no predefined relationships between variables exist; and no generalization of results can be claimed based on sample and population.

This research is dominated by the positivist paradigm. Firstly, existing literature provides us with understanding about e-learning success dimensions. Secondly, the dimensions are placed in a theoretical model with precise description of the model’s dimensions. Third, the relationships between these dimensions and deducing the hypotheses are identified based on prior research. Fourth, the model is empirically tested, by means of quantitative data collection methods, to understand the causal relationships between the constructs. Finally, the researcher objectively and independently interprets the quantitative data collected from participants based on the rigorous nature of quantitative research methods. Additionally, the researcher has employed elements of interpretivism to interpret the results of the hypotheses.

4.3 Research Approach

The current research aims to understand the dimensions that influence the success of e-learning systems by developing a theoretical model based on the literature, determining the relationships between the variables, and empirically testing the model. The study model has been developed by extending the theoretical information systems success model of DeLone and McLean (2003), incorporating other relevant dimensions and indicators from TAM, e-learning quality models, and e-learning user satisfaction models, and testing the model in a different context. As a result, this study provides major contributions to theoretical research in the information systems field, in the context of e-learning, and shares practical experiences of e-learning success determinants in developed countries, such as the UK. This is believed to be vital in extending theories effectively and providing a rich understanding of a phenomenon (Alvesson and Kärreman, 2007).

Theory, as defined by Abdellah et al. (1986), is "a general principle, an explanation of a phenomenon or an abstract generalization that systematically explains the relationship among given phenomena, for purposes of explaining, predicting and controlling such phenomena". Another definition of theory has been provided by James et al. (1982), who see it as "a set of interrelated causal hypotheses that attempts to explain the occurrence of phenomena". According to James et al. (1982), there are five fundamental elements that should be incorporated into any theoretical model:

1. Variables;
2. Relationships among the variables;
3. Theoretical justifications for hypotheses;
4. Boundaries of the model (model context);
5. Stability of the model.

Based on the above, the causality approach is adopted in this research. Causality is adopted in favour of two well-known types of approach: exploratory and descriptive. The exploratory approach is adopted when little is known about the problem and the research problem is investigated to gain a better understanding about the research topic, which will confirm or change the direction of the research. It does not seek to offer final or conclusive results (Saunders et al., 2012). The second type is descriptive research, mainly used to generate a theory rather than testing it. It does not attempt to show or explain the relationships among the factors (Saunders et al., 2012). Thus, the causality approach has been adopted, as it is associated with hypothesis testing, and studies the relationships between the constructs of the model which fit the purpose of the study.

This research attempts to address the five steps in building the model of the study. The constructs of the model are identified from the literature, and the relationships between these constructs are established by linking the constructs based on causal connections and theoretical justifications. Regarding step 4, the boundaries model are identified through the specific constructs and the measures employed to represent each construct of the model, and the connections between them, in addition to a specific instrument designed to test the model and evaluate the constructs of the model.

In relation to stability of the model, this requires studying the causal connections and testing if the causal connections will be consistent over specified time intervals (James et al., 1982). Therefore, a longitudinal study is needed to meet this condition, where data collection occurs at several points of time from the same participants to gain a high degree of certainty of the cause-effect relationships, which was not feasible to conduct in this research due to time constraints and to high risk of participants' attrition in longitudinal studies (Sekaran and Bougie, 2016). In this study, the researcher collected data from participants at the same time in a cross-sectional survey. The validity of the causal connections here is thus based on the time horizon of this research.

4.4 Research Methods

Three broad research methods may be used in any research: quantitative, qualitative and mixed method approaches (Creswell, 2009). Quantification systematically investigates the facts about the phenomena by measuring variables using instruments and analysing the data numerically through statistical analysis (Kreuger and Neuman, 2006). Facts are measured and reality is fixed and predefined. Therefore, research is conducted to test a theory or hypothesis rather than building it, and ultimately supports the hypothesis or rejects it (Braun and Clarke, 2006; Williamsons, 2000). Statistics are used in quantitative research, to interpret the numerical data into useful information, summarise the results, describe patterns, and show relationships.

Different methods are used to obtain quantitative data, for example, experiments, system development, action research, surveys, and the Delphi method (Antonius, 2003). Quantitative data are analysed descriptively or analytically (Oppenheim, 1992). The first type seeks to answer the questions 'how many?' and 'how often?', such as 'how often specific events occur?' and aids in summarising the data. Unlike the descriptive method, the analytical method, which is used to show statistically significant relationships between variables, is broadly applied in causal research. It is designed to answer the question 'why?' and explain and clarify the relationships among the variables (Al-Sabawy, 2013).

On the other hand, qualitative research is concerned with human behaviour, and explores humans' perspectives and thought. It assumes the existence of multiple truths and negotiated reality that are socially constructed to build the theory (Licoln and Guba, 1985). Qualitative researchers collect data using a variety of methods, such as case studies, interviews, focus groups, ethnography, and observation. Data are analysed as themes and are reported in the form of language and qualitative interpretations. Also, the researcher is an integral part of the data, and the reality is subjectively interpreted by the researcher (Saunders et al., 2012).

As stated earlier in this chapter, the study mainly adopts a positivist paradigm, in addition to elements of the interpretivism paradigm. This necessitates using a combination of quantitative and qualitative research methods (i.e., mixed methods). Quantitative methods are used to test the theoretical model and the hypotheses. The results of hypotheses testing are interpreted through qualitative methods. In this regard, the researcher adopted the quantitative analytical survey method in this research. Additionally, an open-ended question is added to the survey to collect qualitative interpretivist data, which provides further insights as to the quantitative results (Creswell and Zhang, 2009). The justification for adopting quantitative analytical survey is due to the following reasons.

- The researcher is separated from the data being collected and objectively interpreting the collected data (i.e., without bias), therefore the subjectivist nature of qualitative data is addressed by adopting a quantitative approach.
- The standards of reliability and validity in quantitative research are assessed by statistical measures through the rigour with which quantitative analyses are conducted (Bryman, 2012, p. 32).
- Generalization can be achieved with quantitative data as the same model can be applied in different contexts and situations, which is one of the limitations of qualitative research (Rea and Parker, 2005).
- One of the objectives of the conducted research is to test the model which cannot be achieved with qualitative data.
- The relationships between the constructs of the model need quantitative data, specifically an analytical (inferential) survey to support or reject them and explain these relationships analytically rather than descriptively which can be obtained with an analytical survey.
- The survey approach allows the researcher to collect data from a large sample in a short time frame.

- The model of the study is a complex model with 11 constructs and 26 relationships, the survey method allows the researcher to ask a wide range of questions to examine the model and provides a sufficient amount of numerical data that can be utilised to examine the model of the study.

Overall, the quantitative survey strategy is deemed suitable in the context of testing the model, and is widely used in the e-learning and information systems field, for example, (Rao, 2002; Selim, 2007; Wang and Liao, 2007; Roca and Gagné, 2008; Al-Sabawy, 2013). Thus, the researcher follows the same approach.

4.5 Data Collection Method

This research is based on the use of a survey as a data collection method, as discussed in the previous section. This section explains the method that was used to distribute the survey. Several ways could be adopted to survey participants, for example, telephone survey, face to face survey, mail survey, or an online survey. In order to select a suitable method, the survey data collection methods are briefly explained as follows.

- In telephone surveys, a survey is conducted using a standardized questionnaire where the telephone is used to contact participants by trained experienced interviewers in which the questions are read to the participants and their responses are recorded (Jackson, 2011).
- In face to face surveys, the researcher goes to the participants' home or business and hands the paper-based questionnaire, the participants are asked to mail it back or the researcher waits to pick it up (Trochim et al., 2015).
- In mail surveys, the questionnaire is sent via mail to a wide number of people, the respondents are free to fill it out and return via mail to the researcher (Trochim et al., 2015).
- In online surveys (Internet surveys), the participants are invited to participate in the survey by completing the questionnaire and inputting their responses over the web. Then their responses are automatically saved in a database (Zikmund et al., 2009).

In this study, the selected data collection method was formed through a mix of online surveys and offline surveys (paper-based survey). The rationale for employing the online survey is explained as follows.

- The surveyed students are likely to be familiar with the Internet and are computer literate, and familiar with Internet questionnaires. Thus, completing the questionnaire is easy and does not require sophisticated procedures from them.

- An online survey can reach a wide range of people. With a large sample size, it is a practical and suitable technique to reach as many students as possible.
- Completion of the online questionnaire gives students the freedom to fill it out at their own convenience and to answer frankly.
- An online survey is a well proven mechanism to handle complex surveys with the flexibility of design which can assist in answering many questions (Sincero, 2012).
- Using an online survey does not require the researcher to be available at the time of distributing the questionnaire (Beins and McCarthy, 2012).
- It is impossible to survey students with a paper-based questionnaire because they are in different locations in the university, so using an online survey would overcome this obstacle by reaching a wide range of students wherever they are.
- An online survey incurs very low costs.
- Data are automatically saved in the survey database which reduces the error of manually entering the responses to zero.

With all the above mentioned advantages of online surveys, the low response rate of online surveys is the most common dilemma facing researchers (Zikmund et al., 2009; Fan and Yan, 2010; Samarasinghe, 2012; Al-Sabawy, 2013). Thus, to improve the response rate, the researcher decided to adopt offline (paper-based) questionnaire as well. Using this strategy in data collection can assist in taking the advantages of both online surveys and offline surveys and overcome their disadvantages and obstacles (Dillman et al., 2014). The method was used effectively in prior e-learning research, such as by Samarasinghe, (2012) and Al-Busaidi et al., (2012).

4.6 Research Context and Population

4.6.1 Research Context Population

The context of the current research is the University of Warwick in the United Kingdom. The population is formed of students enrolled in the Moodle LMS for the purposes of e-learning. According to the official website[4], the total population is approximately 26000 students: 16000 undergraduates, and 10000 postgraduates). In addition to the reputable position of the University of Warwick in the UK and worldwide, the researcher also selected the University of Warwick due to accessibility of data, since the researcher is a student in the university and familiar with it, and can easily contact the staff at the University, thus saving time and cost.

[4] Accessed January 15, 2018 from https://warwick.ac.uk/about/profile/people/

The university has four faculties: Faculty of Arts; Faculty of Science and Engineering, Faculty of Medicine; and Faculty of Social Sciences. Table 4.10 provides some information about the departments across the faculties and the size of each faculty compared to the total population.

Faculty	Departments	No of Student	Percentage*	Gender
Faculty of Arts	History Comparative Studies Film and TV Studies History of Art	2861	11.56%	47% Male, 53% Female
Faculty of Science and Engineering	Chemistry Computer Science Engineering Life Sciences Mathematics Physics Psychology Statistics WMG	9712	37.36%	
Faculty of Medicine	Medical school	1340	5.73%	
Faculty of Social Sciences	Economics Philosophy Sociology Politics Law WBS Applied Linguistics Education	10902	44.45%	

Table 4.10: The distribution of students by number among the departments and faculties

* Faculty populations as % of total student numbers

The researcher selected Moodle LMS to test the model of the study because the University of Warwick has adopted Moodle as the main e-learning system designed to support teaching and learning materials and activities, and to provide a number of interactive activities including forums, wikis, quizzes, surveys, chat and peer-to-peer activities, serving most of the departments and students. In addition, Moodle is widely used in the educational sector generally and in HE specifically.

4.6.2 Research Sampling Technique

Sampling is "the process of selecting a representative group (sample) from the population under study" (McLeod, 2014). The population in the definition refers to the total group of subjects, and the chosen sample usually represents a manageable subset of the population. The sampling process includes the following stages (Dudovskiy, 2018).

1. Defining the population. In this study, the population is formed by the University of Warwick students enrolled in the Moodle LMS. However, because this population is too large to work with, sampling provides us with techniques to obtain samples from this large population and makes the research data collection more manageable and efficient.

2. Choosing a sampling method. In this regard, different methods for sampling are found under two categories: probability sampling and non-probability sampling (Figure 4.27). In the first type, probability sampling, there is an equal opportunity for each part of the population to be selected (Saunders et al., 2012). The second type of sampling is non-probability sampling in which one cannot anticipate the chance of selecting each element in the sample (Saunders et al., 2012).

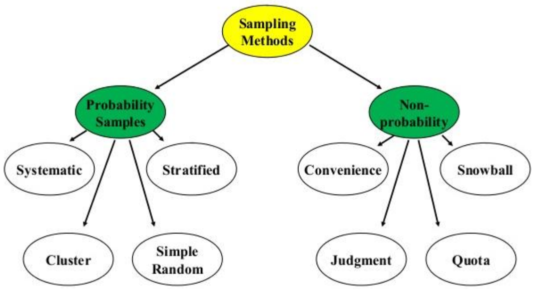
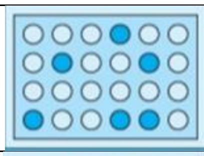
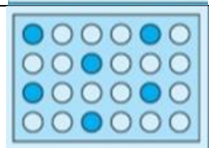
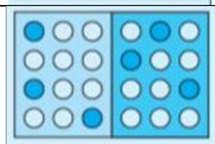
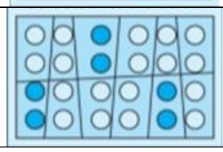
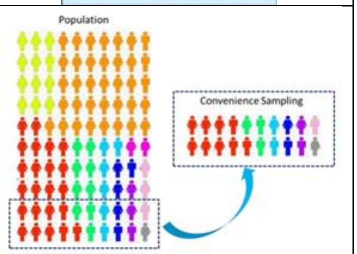
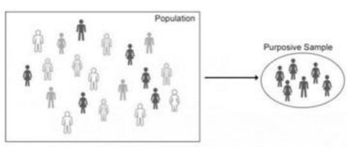


Figure 4.27: Classification of Sampling Methods (Atwebembeire, 2014)

A brief description about each sampling technique is introduced in Table 4.11 (Saunders et al. 2012; Atwebembeire, 2014; Dudovskiy, 2018).

Approaches	Techniques	Description	Illustration
Probability Sampling Approach	Simple random sampling	Each person has an equal chance of being selected.	
	Systematic sampling	After a random start point, every n^{th} person is selected.	
	Stratified sampling	Simple random samples selected from each of several strata.	
	Cluster sampling	An area is divided into geographic clusters and some clusters are selected for inclusion.	
Non-probability sampling	Convenience sampling	Collecting data from conveniently available participants. All members are invited to participate and there is no selection criteria. In other words, it is taking what is first available and convenient to get data from.	
	Judgement / purposive sampling	Purposive sampling where members selected for the study sample are likely to provide data relevant to the research problem, based on the own judgment of the researcher.	

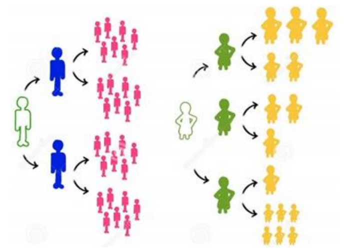
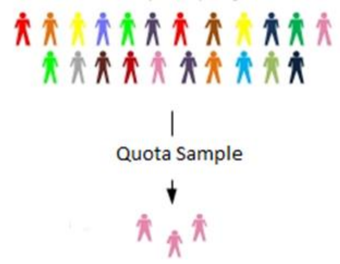
Approaches	Techniques	Description	Illustration
	Snowball / referral sampling	A popular sampling technique used when characteristics to be possessed by samples that are rare and difficult to find (secretive) and focus on a specific or company that has primary data from its employees.	
	Quota sampling	A sampling technique where the population is divided into groups or subsets. Each group represents certain characteristics of the population selected by the researcher and the researcher selects a certain number from each group. It is similar to stratified sampling except that the researcher uses non-random sampling methods to gather data in which the sample includes members meeting all the characteristics being researched.	

Table 4.11: Sampling approaches and techniques

Ethical consent was obtained from Biomedical and Scientific Research Ethics Committee (BSREC) at the University of Warwick and was granted (REGO-2017-1917). The second step was to contact the departments and module organisers, to seek their permission to survey the students. The initial email invitation and the survey were sent to the departments to obtain their consent to disseminate the questionnaire. The module instructors who were more likely to agree were then contacted. Permission from the following departments and modules' leaders was obtained (Table 4.12).

Faculty	**Department**	**Total number of Modules**	**Total number of unique students**
Faculty of Science and Engineering	Life Sciences	5	268
	Chemistry	5	154
	Physics	1	94
	Mathematics	1	204
	Statistics	1	147
	Engineering	6	318
	WMG	2	134
Faculty of Social Sciences	Economics	4	363
	Law	1	92
Faculty of Medicine	Medicine	2	176
Total		**28**	**1453**

Table 4.12: Departments and modules from which consents were taken to survey their students

Therefore, the coordinators of 28 modules gave their consent and gave information about the number of students enrolled in their module. The departments involved have online components and actively use Moodle LMS. It is worth mentioning that according to the University of Warwick website, the first departments to adopt Moodle were Life Sciences and Chemistry. These departments “have particular drivers and local resources to use Moodle for teaching and learning” and were more likely to respond.

In the light of the previous review of sampling methods, and according to the permissions obtained, the researcher chose a *convenience sampling* as a sampling method in this research. The reasons behind adopting convenience sampling are related to pragmatic and ethical concerns, as consent was given only from these departments and instructors, and additionally to surveying the most conveniently available and accessible students because of research’s fund and time limitation (Denscombe, 2014; Saunders et al., 2012).

3. Determining the sampling frame. This is the number of students within the target population who can contribute to the research. In this study, the total population is 26000 students, and the sampling frame is 1453 students.

4. Determining the required sample size. The size of the sample is a crucial issue that researchers face. This study adopts Partial Least Squares - Structural Equation Modelling (PLS-SEM) to analyse the quantitative data (section 4.9). In the study conducted by Saleh (2006), it was revealed that the sample size could be as low as 72, and as high as 844. Researchers noted that small sample size may lead to model misspecification, low reliability of indicators, failure to achieve the assumptions of normality, and further problems in SEM. Researchers, on the other hand, agree that a large sample size in SEM is required to retain power and obtain stable parameter estimates (Schumacker and Lomax, 2004). The standard conventional sample size as recommended by Tabachnick and Fidell, 2001; Barrett, 2007; and Kline, 2011 for sophisticated statistical analysis using SEM considers a sample of 200 as fair, and 300 as good. Hair et al. (2016) proposed 300 as a minimum sample size for models that contain large numbers of constructs (more than seven) to produce valid results. There is also a rule of thumb of having 5 observations per variable in the model on the condition of normally distributed data. Alternatively, 10 observations are needed per variable for other distributions (Bentler and Chou, 1987).

Considering the complexity of the study model, and taking the recommendations of (Tabachnick and Fidell, 2001; Barrett, 2007; Hair et al. 2016; Kline, 2011), a sample of 300 should be sufficient and meets the standards found in the literature for the purposes of conducting PLS-SEM and retains the power of statistical analysis to obtain robust results.

4.7 Building the Survey Instrument

4.7.1 Items of the Questionnaire

The questionnaire was prepared to empirically test the proposed model. The items comprising the questionnaire were adopted from previous studies in the same field (Table 3.8). The first part was allocated to seven items related to demographic information. In the second part, there were 11 constructs and 63 items, initially, for measuring them. At the end of the questionnaire, one open-ended question was added.

4.7.2 Scale of Measurement

The Likert scale is the most popular and common scale to measure people's beliefs, opinions, and perceptions about subjects under investigation (Stangor, 2014). There are a variety of scales of three, five, seven or nine points. The most recommended scale is the one with 5 points, to increase response rate and response quality along with reducing respondents' frustration level and time to think about the answers (Babakus and Mangold, 1992; Sachdev and Verma, 2004; Dawes, 2008; Bouranta et al., 2009). Bearing in mind these issues, and considering the number of questions in the survey, the 5-point Likert scale is used in this questionnaire with a scale of 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree.

4.7.3 Validity of the Survey Instrument

The validity of the measurements in the survey instrument was carried out at three different levels before the actual survey: expert study, face validity and pilot study (Figure 4.28). More details are given as follows.

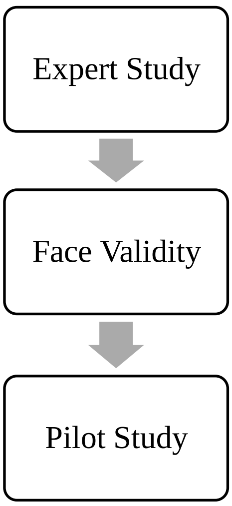


Figure 4.28: Instrument validation stages in this research

Expert Study was the first step after constructing the measurement items for the constructs of the model. The measurement items were obtained from the literature review and were deemed to represent all aspects of the construct (Lewis et al., 2005). As a complementary step, experts' opinions regarding the items adopted to reflect each construct were harnessed (Walker and Fraser, 2005). Feedback from experts helped the researcher to examine the measurements adopted in the survey, prior to testing the theoretical model.

E-learning experts were asked to assess the importance of each factor in the model, through a questionnaire as a method of data collection. An experts' questionnaire was used as a data collection method, for many reasons: "participants are encouraged to answer frankly; avoid interview bias; eliminating variation in the questioning process; ease in data collection and analysis; short timeframe in collecting data; and it is economical." (Powell and Connaway, 2004).

To make the model applicable to a wider context, two categories of experts were considered: researchers who had sufficient knowledge and had engaged in sufficient research in the field of e-learning systems evaluation, and instructional designers who were involved in the design and implementation of e-learning courses. The list of the experts was obtained from a previous conference that the researcher had attended (International Conference on e-Learning, ICEL, 2017, USA). The distribution of experts is shown in Table 4.13.

No.	Institution	Country	No. Experts
1.	E-learning Industry	USA	3
2.	University of Central Florida	USA	5
3.	University of Warwick	UK	3
4.	Brunel University	UK	1
5.	Edinburgh University	UK	1
6.	University of Southern Queensland	Australia	1
7.	Korea Advanced Institute of Science and Technology	Korea	1
8.	University of Novi Sad	Servia	2
9.	Middle East Technical University	Turkey	2
10.	Taif University	Saudi Arabia	3
11.	King Khaled University	Saudi Arabia	1
12.	International Islamic University, Kuala Lumpur	Malaysia	1
13.	Sultan Qaboos University	Oman	2
14.	Institut Superieur S'ingenierie and Des Affaires	Maghreb	2
15.	University of Mosul	Iraq	2
Total		**30**	

Table 4.13: Distribution of E-learning Experts

E-learning experts were asked to rank the relevance of the items based on a 3-point scale (Lawshe, 1975): Essential, Important (but not essential), and Not Relevant. In addition, an open-ended question was added "What are the factors that are important for the evaluation of e-learning systems success?" to give experts the opportunity to submit their opinions about factors that might not be included in the close-ended question. Based on the responses received, the items (overall usefulness, overall satisfaction) were added to the two constructs perceived usefulness and perceived satisfaction respectively. A statement was added to the support system quality construct ‘Providing information about accessibility of content and any other personal data in the e-learning system’. Additionally, the interactivity statement was broken down into two: one for the existence of interactivity and communication features and one for the effective communication to provide good coverage for the educational system quality construct. Based on experts’ feedback, measurements were confirmed, and no item was deleted.

Face Validity was the second step after finalizing the indicators with experts. It was done with 2 experts from the context of the research: an instructor and an IT senior consultant. The model of the study along with the survey designed to measure the constructs of the model were discussed with the two experts in two semi structured interviews. The interviews sought to explain two main purposes. First, they aimed to elicit the interviewees’ comments, opinion, and feedback about the factors employed to measure each construct in the model in general and to seek their help in identifying any context-related factors that might be relevant to the students. Secondly, they were intended to identify any ambiguous questions, and to determine if the questions are understandable to students in the context of the study. The two interviewees came to an agreement as to the importance of regularly evaluating the existing e-learning system and obtaining students’ feedback about the system. The factors employed in the instrument to evaluate the e-learning system in the context of the study were relevant and suitable. Based on their comments and recommendations, the questionnaire was modified iteratively. The suggestions and comments of interviewees assisted in rewording some questions to ensure clarity, and to be more appropriate and concise to the students.

Pilot study was the last step before the main data collection. This is a trial and a small version of the main study to test the validity of the instrument which will be used on a larger scale (Thabane et al., 2010). The pilot study was carried out with one class in the Engineering Department at the University of Warwick, using a paper-based questionnaire. The selection of the pilot sample was based on the fact that the module organizer was the first to agree to survey their students after sending invitations to the departments. The total number of students was 26 and the total number of questionnaires returned was 26 (100% response rate). Some students commented on one question in the demographic part, ‘Field of study’, and asked for the subjects to be added next to the name of the faculty for more clarity. No problems were detected in the pilot study. The data obtained from the pilot study were included with the main data.

4.7.4 The Final Items of the Survey

The first part contained seven items to collect demographic information: gender (male, female, other); age (less than 21, 21-30, more than 30 years); enrolled course (undergraduate, postgraduate); number of modules that respondents have been enrolled in via Moodle (one, more than one); experience with Moodle (less than a year, 1-2 years, more than 2 years); field of study (faculty of medicine, faculty of science and engineering, faculty of social science); nature of using Moodle (access learning resources; accomplish and submit assignments or quizzes; interact with my instructors and colleagues; other).

The second part incorporated the items used to assess the 11 constructs of the model. The final items consisted of 58 questions adopted from prior studies in the information systems and e-learning fields, which were reworded to fit in with the context of this study. The final items were prepared based on the results, comments, and feedback obtained from the three validity steps. The items employed to measure each construct are now explained.

4.6.4.1 Technical System Quality (TSQ)

The items used to assess this construct were adopted from information system studies and prior e-learning research (DeLone and McLean, 2003; Selim, 2003; Sedara et al., 2004; Ozkan and Koseler, 2009; Hassanzadeh et al., 2012).

The focus of this construct is on assessing the technical characteristics of the e-learning system and related issues, for example, to assess whether the e-learning system is easy to use, free of bugs, consistent, secure, and has the required functions. 11 items were designed to capture multiple aspects in relation to this construct. Table 4.14 shows these items.

Code	Statement	Aspect
TSQ1	It is easy to use Moodle	Ease of use
TSQ2	It is easy to understand the structure of Moodle and how to use it	Ease to learn
TSQ3	Moodle meets my requirements and I can find the information I need	User requirements
TSQ4	Moodle includes the necessary features and functions I need	System features
TSQ5	Moodle is always available for me to perform learning activities	System availability
TSQ6	Moodle is flexible to interact with	Flexibility
TSQ7	All components within Moodle are fully integrated and consistent	Integration
TSQ8	Moodle launches and runs right away	Reliability
TSQ9	Moodle does not crash frequently	Fulfilment
TSQ10	Moodle protects my information from unauthorized access by logging only with my account and password	Security
TSQ11	Moodle provides me with a personalised entry page (e.g., showing my modules, recommending additional modules and courses)	Personalization

Table 4.14: Items of Technical System Quality

4.6.4.2 Information Quality (INQ)

The information quality construct is concerned with the desired characteristics required by the students in relation to the content and information in the e-learning system such as, clarity, up to date content, and sufficiency of information. Seven items, adopted from DeLone and McLean (2003); Selim (2003); Sedera and Gable (2004); Roca et al. (2006); and Ozkan and Koseler (2009), were operationalized to represent this dimension, as shown in Table 4.15.

Code	Statement	Aspect
INQ1	Moodle has provided me with sufficient and required information	Sufficiency
INQ2	Information and resources needed from Moodle are always accessible	Accessibility
INQ3	Information from Moodle is in a form that is readily usable	Usability
INQ4	Information in Moodle is concise and clear	Conciseness
INQ5	The structure of Moodle is well organized into logical and understandable components	Understandability
INQ6	The content of Moodle is up to date	Up to date content
INQ7	I perceive the design of Moodle (e.g., fonts, style, colour, images, videos) to be good and meets the quality standards	Content design quality

Table 4.15: Items of Information Quality

4.6.4.3 Service Quality (SRQ)

Service quality construct is concerned with the overall support delivered by IT services personnel to users. The five items utilized to assess this construct were from DeLone and McLean (2003); Chang and King (2005); Holsapple and LeePost (2006); and Hassanzadeh et al. (2012). The items are presented in Table 4.16.

Code	Statement	Aspect
SRQ1	There are enough and clear instructions/training about how to use Moodle	Providing guidance services
SRQ2	Moodle provides a proper online assistance and help	Providing help
SRQ3	The IT services staff is available and cooperative when facing an error at Moodle	Staff Availability
SRQ4	The IT services staff understands the specific needs of students	Fair understanding
SRQ5	I receive satisfactory and timely response from the IT services staff	Responsiveness

Table 4.16: Items of Service Quality

4.6.4.4 Educational System Quality (ESQ)

This construct is concerned with the features of the e-learning system that facilitate and improve conductive learning environment. The items were adopted from the studies of Hassanzadeh et al. (2012); Sun et al. (2008); and Selim (2003). Table 4.17 shows these items.

Code	Statement	Aspect
ESQ1	Moodle provides interactivity and communication facilities, such as, chat, forums, and announcements.	Interactivity and communication
ESQ2	I believe that communication facilities have been effective learning components in my study	Effective communication
ESQ3	Moodle provides me with different learning styles (e.g., flash animation, video, audio, text, simulation, etc.) and they are interesting and appropriate in my study	Diversity of learning styles
ESQ4	Moodle provides evaluation components and assessment materials (e.g., quizzes; assignments)	Assessment materials

Table 4.17: Items of Educational System Quality

4.6.4.5 Support System Quality (SUP)

This construct is related to the supportive issues in the e-learning system in relation to ethical and legal issues, and the popularity and promotion of the e-learning system that have influence on users. Four items adopted from Khan (2005) and Ozkan and Koseler (2009) were employed to assess this dimension. Table 4.18 shows these items.

Code	Statement	Aspect
SUP1	Moodle provides appropriate information about plagiarism issues when submitting assignments through the system,	Ethical issues
SUP2	Moodle provides information about behavioural considerations when communicating with students or with instructors	Behavioral considerations
SUP3	Moodle provides information about accessibility of content, permission for viewing course materials, and any other personal data in the system	Legal issues
SUP4	If it is optional, I would still prefer to use Moodle as a supportive tool in the module	Promotion of the e-learning system

Table 4.18: Items of Support System Quality

4.6.4.6 Learner Quality (LER)

This dimension is concerned with the quality of the learner in different aspects which influence their utilization of the e-learning system. This construct has been proven to be a valid and reliable construct in e-learning research. The items were adopted from (Davis et al., 1989; Roca et al., 2006; Sun et al., 2008; Ozkan and Koseler, 2009). Table 4.19 shows these items.

Code	Statement	Aspect
LER1	I believe it is good to use Moodle	Learner’s behaviour
LER2	I have a positive attitude toward using Moodle	Learner’s attitude
LER3	I am not intimidated by using Moodle	Learner’s anxiety
LER4	My previous experience with e-learning systems and computer applications helped me in using Moodle	Learner’s previous experience
LER5	I am able to perform tasks in Moodle successfully	Learner’s self-efficacy

Table 4.19: Items of Learner Quality

4.6.4.7 Instructor Quality (INS)

This construct is concerned with aspects related to the instructor which are important for effective utilization of the e-learning system. Five items were used to capture these characteristics, adopted from Roca et al. (2006), Sun et al. (2008), and Ozkan and Koseler (2009). Table 4.20 presents these items.

Code	Statement	Aspect
INS1	I use Moodle as recommended by my instructors	Subjective norm
INS2	I think instructor's enthusiasm about using Moodle stimulates my desire to learn	Instructor's enthusiasm
INS3	I receive prompt response to questions and concerns from my instructors in Moodle	Instructor's responsiveness
INS4	I think communicating and interacting with instructors are important and valuable in Moodle	Instructor's interactive communication
INS5	Generally, my instructors have a positive attitude to utilization of Moodle	Instructor's attitude

Table 4.20: Items of Instructor Quality

4.6.4.8 Perceived Satisfaction (SAT)

Perceived satisfaction is an important construct concerned with users' level of satisfaction with the e-learning system. Four items were appointed to assess the degree of perceived satisfaction: satisfaction with the performance, enjoyable experience, satisfying education needs, and overall satisfaction. These items were adopted from Arbaugh (2000), Hassanzadeh et al. (2012), and Cidral et al. (2018). Table 4.21 presents these items.

Code	Statement	Aspect
SAT1	I am satisfied with the performance of Moodle	Satisfaction with system performance
SAT2	I enjoy using Moodle in my study	Enjoyable experience
SAT3	Moodle satisfies my educational needs	Providing educational needs
SAT4	Overall, I am pleased with the experience of using Moodle	Overall satisfaction

Table 4.21: Items of Perceived Satisfaction

4.6.4.9 Perceived Usefulness (USF)

Perceived usefulness is a perceptual measure of the degree users believe that using the e-learning system would enhance their learning performance. Four items were employed to measure this construct adopted from Venkatesh and Davis (2000), Selim (2003), and Roca et al. (2006). Table 4.22 shows the items.

Code	Statement	Aspect
USF1	Using Moodle enables me to accomplish my tasks more quickly	Accomplishing tasks quickly
USF2	Using Moodle improves my learning performance	Improving learning performance
USF3	Using Moodle helps me learn effectively	Effective learning
USF4	Overall Moodle is useful	Overall usefulness

Table 4.22: Items of Perceived Usefulness

4.6.4.10 System Use (USE)

System use is a measure of the actual usage of the e-learning system, which is the degree to which the user is dependent on the e-learning system for the execution of learning tasks. The items were used from DeLone and McLean (2003) and Selim (2003) as shown in Table 4.23.

Code	**Statement**	**Aspect**
USE1	I use Moodle frequently	Frequency of use
USE2	I depend on Moodle in my study	Dependence on system
USE3	I use Moodle regularly	Regular use
USE4	On average, I spend long time on using Moodle	Duration of use

Table 4.23: Items of System Use

4.6.4.11 Benefits (BNT)

This construct is concerned with students' perceptions of the expected general benefits, i.e., the overall impacts on students resulted from using the e-learning system, in terms of increasing knowledge, improving the learning process, ease of interaction and communication, and time and cost saving. Five items adopted from DeLone and McLean (2003), Hassanzadeh et al. (2012), Almutairi and Subramanian (2005), and Holsapple and LeePost (2006). Table 4.24 presents the items used to assess this construct.

Code	**Statement**	**Aspect**
BNT1	Using Moodle has increased my knowledge and helped me to be successful in the module	Increasing knowledge
BNT2	Moodle is very effective education tool and has helped me to improve my learning process	Improving learning process
BNT3	Moodle makes communication easier with the instructor and other classmates	Easier interaction and communication
BNT4	Moodle saves my time in searching for materials and cuts down expenditure such as paper cost	Time and cost saving
BNT5	Moodle has helped me to achieve the learning goals of the module	Achieving learning goals

Table 4.24: Items of Benefits

At the end of the questionnaire, one open-ended question was added to elicit students' comments regarding the e-learning system '*Do you have any other comments related to Moodle*?' The purpose of adding this question was to give students the opportunity to submit their opinions about the e-learning system that might not be included in the closed-ended questions.

4.8 Data Collection and Responses Rate

4.8.1 Data Collection

The data collection method, as stated earlier, was a mixed-mode survey of online and offline questionnaires (Dillman et al., 2014). Data collection was carried out in the third term over a period of two months in May and June, 2018. The initial email invitation and the survey were sent to the departments to obtain their consent to disseminate the questionnaire. The module instructors who were more likely to agree were then contacted (Appendices A and B show the invitation email and the questionnaire).

The researcher allowed the instructors to state their preferences in surveying their students online or paper-based in one of the classes running in term 3, academic year 2017/18. For those who agreed to disseminate the survey online, the web link of the online questionnaire was sent to the instructor and it was posted online on their module page. For those who were happy to give 5 minutes at the end of one of the classes running in the term, data was collected using a paper-based questionnaire. Some instructors preferred to hand the paper questionnaires to them directly, and they distributed them to their students at their own convenience. The researcher collected them after.

Participation in the study was encouraged by offering instructors the survey results. When necessary, informal interviews were conducted to clarify the objectives of the study and discuss the research purpose and procedures with the instructors and some departments. Emails were sent and telephone calls were made for further details. Instructors were informed that the study was anonymous and private, and not targeting any specific module; rather, the questions were asked based on the overall modules the students had been enrolled in via Moodle LMS. They were also informed that the questionnaire was totally anonymous. Neither personal questions nor specific questions regarding the module were asked. To minimize bias and obtain consent, it was clarified that all the data would be treated with total confidentiality and the module names would not be inferred when reporting the data. The number of responses received online was 180, and the number of paper questionnaires collected from the classrooms was 408. The total number of responses received was 588.

4.8.2 Response Rate

The total response rate for both types of survey, as shown in Table 4.25, was 40.5%. The response rate was approximately 72% for the paper survey, which is considered high (Nulty, 2008): "The best reported response rate obtained for on-paper surveys was 65% when the class size exceeds approximately 500 students."

Regarding the online survey, the response rate for the online survey was approximately 20%. Though 20% is low compared to 72% for the paper survey, it is still considered a good response rate and within the acceptable rate of Internet survey studies (6% - 22%) according to Rao (2002) and Nulty (2008). Similar results were obtained in the study conducted by Nulty (2008), where the response rates between the two methods, Internet survey versus mail survey, were compared. The researcher found a response rate of 12% for Internet survey compared to 70% for the mail survey.

The researcher believes that the main reason for the low response rate in the online survey could be the time of data collection. The data collection was done in term 3 of the academic year and many students were not reachable in this term; some were too busy due to exam preparation. Also, the researcher relied on the instructors to post the link of the online survey on their module pages, and students were not sent follow-up reminders (which is considered the most powerful way of improving the response rate (Dillman et al., 2014), and some students might not see the link. The length of the questionnaire could also have been another reason for students not taking part in the research. Furthermore, some instructors mentioned that students were overloaded with too many requests from researchers seeking to survey them and students did not respond to them.

	Sent	Received	Percentage
Online survey	883	180	20.3 %
Offline survey	570	408	71.6 %
Total	1453	588	40.5 %

Table 4.25: Response rate

4.9 Model Testing Approach

After collecting the data, preliminary data analysis was conducted as a first step to check for any missing data, data entry errors, outliers, and normality. Descriptive data were presented for the demographic part of the survey, followed by descriptive statistics for the constructs of the model (chapter 5). Finally, the model was tested based on testing the measurement model and the structural model (chapter 6). In addition to the content analysis of students' comments. SPSS version 24 was used for the purposes of preliminary data analysis. SmartPLS version 3.2.8 was utilized to test the measurement and structure model. NVivo 11 was used for the content analysis of students' comments. More details are given in the following chapters.

4.10 Chapter Summary

This chapter outlined the overall research approach and methodology of the research. The research adopted a positivism paradigm to test the model, which depends on a priori fixed relationships. Quantitative and qualitative methods were used to validate the model. An analytical survey was adopted because this fits the positivism paradigm, and a wide range of data were collected to empirically examine the model. The validity of the measurements used in the survey instrument was demonstrated at three stages: expert study, face validity, and pilot study. The model was tested using data collected from students at the University of Warwick using Moodle LMS for the purposes of e-learning. Ethics were considered prior to collecting data. The sample was considered as sufficient in conducting quantitative analysis using PLS-SEM. Response rates were presented. Finally, the model testing approach was briefly introduced in this chapter. The next chapter is allocated to presenting the preliminary data analysis.

CHAPTER FIVE: PRELIMINARY DATA ANALYSIS

5.1 Chapter Introduction

The purpose of this chapter is to present the preliminary data analysis. Section 2 presents the first step 'data screening' which is done to check for any missing data, data entry errors, outliers, and normality. Descriptive data for the demographic part of the survey are presented in section 3, followed by descriptive statistics for the constructs of the model in section 4.

5.2 Data Screening

Before proceeding to data analysis, it is vital to prepare the data and ensure that any issues are diagnosed and handled that might affect the quality of the data and lead to misleading results, which, in turn, would have a significant effect on the conclusions drawn. Data screening will ensure that our data are clean and ready for further analysis. Different strategies are used in this research to ensure purification of data, and the way in which we deal with them is explained subsequently.

5.2.1 Examination of Data Entry Errors

In the online survey, the data were transferred directly to the statistical software, not manually, so no transcription errors happened in entering the data. In spite of this, the researcher checked the data via frequency distributions and cross-tabulations in SPSS. The number of values in the cells was 11700, which were the same as the number of the cells required to fill in the 180 questionnaires.

The examination of the data entry process for the paper questionnaire was done in two steps. As a first step, all questionnaires were numbered and all entries were verified case by case by the researcher as a first check, and another check was conducted by a volunteer who was outside of the study, to ensure accuracy. Three mistakes were found in the data entry process and these were modified based on the questionnaire numbers. As a second step, the frequency distribution statistics ensured the accuracy of data and all answers ranged between 1 to 5 (strongly disagree=1, strongly agree=5), which is the range of scale used in this study.

5.2.2 Unengaged Responses (Suspicious Response Patterns)

Sometimes survey respondents may respond randomly to the survey without considering the content of the items in a way that does not accurately reflect their true feelings. For example, respondents may answer all items with the exact same response (straight lining). Other respondents may mark similar items with entirely different items (Meade and Craig, 2012). As these responses may affect the quality of data and the outcome of the research, a close examination of each response was made before analysing the data. There is no single way to detect such responses. One possible way could be through visually inspecting the responses. However, with 588 responses it was tricky to inspect all of the data. A good way to detect unengaged responses is by finding the standard deviation for each response, where a value of zero variance on a raw indicates that it is the exact same value for every question. As a result, two responses were detected with "straight line" answers for all the items and were excluded from further analysis.

5.2.3 Missing Data

Missing data occurs when participants do not fill in some items in the survey. In this regard, Peat and Barton (2005, p.12) stated that "the seriousness of the missing values problem depends on the pattern of missing data, how much is missing, and why it is missing."

It is worth mentioning that all fields in the online survey were mandatory, so missing data were unlikely to happen with the 180 responses received online.

In examining the completeness of the paper questionnaire, of 408 observations, 49 responses were incomplete, and 23 responses out of the 49 were incomplete with more than 20% data missing of the overall questionnaire.

The action taken was to exclude those cases from the data analysis. This deletion was done based on the recommendation of Hair et al. (2010). On the other hand, it was observed that the other 26 of those 49 questionnaires had missing data randomly where the percentage of missing data was extremely low, as shown in Table 5.26.

Number of questionnaires	% Missing
15	1.7
6	3.4
3	5.2
1	6.9
1	8.6
Total 26	

Table 5.26: Percentages of Missing Data

The imputation method is preferred as a means of estimating the missing data in cases where the percentage of missing data is under 10% (Hair et al., 2010). Different ways for imputation are found, including expectation maximisation, listwise deletion, and mean substitution. Listwise deletion is the least accurate method to expect missing data, so it was excluded (Roth, 1994). For expecting the missing data in our survey, the expectation maximisation EM was preferred for imputing missing data over the mean imputation. This was because it is more accurate, allows retaining statistical power, and produces less biased estimates than mean imputation (Roth, 1994; Ghomrawi, et al., 2011). Thus, 383 out of 408 were considered valid and complete for further analysis (Table 5.27).

	Received responses	Incomplete		Unengaged responses	Complete
		Excluded	Imputed		
Online survey	180	-	-	-	180
Offline survey	408	23	26	2	383
Total	588	23		2	563

Table 5.27: The total number of responses received

5.2.4 Outliers

After the identification of missing data and unengaged responses, outliers should be removed. Outliers are "data points that deviate markedly from others" (Aguinis, et al., 2013). They could be univariate, which are extreme values (well above or well below the majority of the cases) on one variable, or multivariate, that is an unusual combination of scores on two or more variables that distort statistics (Tabachnick and Fidell, 2001; Holmes-Smith 2011). The issue of outliers is important, and can lead to falsely accepting or rejecting hypotheses and influencing substantive conclusions regarding the relationship between variables (Aguinis et al., 2013).

It is noteworthy that all questions in the survey were closed-ended questions, either 5-point Likert scale or checkboxes (for the demographic part), where the participant is required to click on the box next to the desired answer, leaving no room for participants to enter abnormal values. Nevertheless, the researcher checked the data for univariate outliers (inaccurate values) via frequency distributions, checking the maximum and minimum values for each item and also through running the histogram distribution for each item (Holmes-Smith, 2011). The values for the demographic part were all within the given choices and the values for the items of the questionnaire were confirmed at between 1 and 5 for the Likert scale items which is the scale used in this study.

Multivariate outliers were identified in our data using Mahalonobis distance technique M-D (0.95 confidence level, 0.001 threshold value as suggested by Tabachnick and Fidell (2007), the degree of freedom DF=10 which is equal to the number of predictors in the regression). The results of the M-D test detected 11 cases as outliers.

Different techniques exist to handle outliers. Before deciding which one to choose, the researcher checked the 11 cases one by one. It was found that these values were actual values (legitimate) obtained from the respondents and not because of error in the data entry or instrumentation. In this case, there are three well-known techniques to treat outliers (Parke, 2012). The first one, which is the most undesirable option, is the deletion of the case from further analysis. The second option is transforming the variable by replacing the values into the smallest or largest non-outlier value, in an attempt to reduce the effect of outliers. The third technique which was adopted in this study is to conduct data analysis with and without outliers and see if the results are influential or not in the analysis. The researcher conducted the *t*-test with two data sets (with and without outliers) and the results generated are shown in Table 5.28.

Constructs	Mean		Std. Deviation		Std. Error Mean		Sig. *p*-value
	Without N=552	With N=563	Without N=552	With N=563	Without N=552	With N=563	
Technical System Quality	4.0455	4.0389	.47546	.48327	.02020	.02037	.758
Information Quality	3.9489	3.9477	.65195	.65722	.02770	.02770	.838
Service Quality	3.5166	3.5197	.66971	.67594	.02845	.02849	.819
Educational System Quality	3.9174	3.9192	.61830	.62077	.02627	.02616	.917
Support System Quality	3.6187	3.6217	.72339	.73082	.03073	.03080	.813
Learner Quality	4.1838	4.1766	.59906	.61025	.02545	.02572	.724
Instructor Quality	3.8809	3.8845	.63981	.64799	.02718	.02731	.761
Perceived Satisfaction	4.1286	4.1141	.71981	.73832	.03058	.03112	.799
Perceived Usefulness	4.0487	4.0244	.74166	.77506	.03151	.03266	.603
System Use	4.3127	4.3006	.82335	.84384	.03498	.03556	.718
Benefits	3.9072	3.8970	.69987	.71976	.02973	.03033	.676

Table 5.28: SPSS Output for Descriptive Statistics of the t-test with and without Outliers

As shown in the table above, the mean value for the two data sets indicates no significant difference between the two means. The statistical results retrieved from SPSS show that *p*-values for both groups were greater than .05 for all items, which indicates an insignificant difference. Thus, outliers do not affect the outcomes of the t-test.

As a result, the researcher decided to keep the outliers in the data analysis. This is because 11 outliers were expected within a large sample of N=563, with no significant impact on the results.

5.2.5 Assessment of Normality

Normal distribution of the data around its mean can be tested using skewness (tails) and kurtosis (peaked or flat distribution) indicators (Peat and Barton, 2005). Outliers are considered to be the cause of non-normal distribution of the data (Peat and Barton, 2005, p.32). The descriptive statistics in SPSS for the skewness and kurtosis values were obtained for each item and for each construct. The skewness and kurtosis values for each item can be found in Appendix C. The results for each construct are shown in Table 5.29 below. The P-P plots can also be used to visually check the normal distribution of data. The plots show normally distributed variable if the dots align (relatively) linear in a 45º angle (along the continuous line drawn).

In this study, the P-P plots were retrieved for each construct. The shapes of distributions of all constructs demonstrated an acceptable normal distribution of data (see Appendix D). The skewness and kurtosis values were also retrieved. Table 5.29 summarises the skewness and kurtosis values for each construct.

Constructs	Skewness	Kurtosis
Technical System Quality	-0.344	0.044
Information Quality	-0.421	0.489
Service Quality	0.442	-0.248
Educational System Quality	-0.351	0.026
Support System Quality	0.085	-0.423
Learner Quality	-0.531	0.249
Instructor Quality	-0.190	-0.323
Perceived Satisfaction	-0.766	1.007
Perceived Usefulness	-0.655	0.321
System Use	-1.612	1.539
Benefits	-0.604	0.449

Table 5.29: SPSS Output of Skewness and Kurtosis (N=563)

Peat and Barton (2005, p.31) have indicated that "Any values above +3 or below −3 are a good indication that the variable is not normally distributed." Following their recommendation, the results obtained from SPSS shown in the table above and in Appendix C show that the data is within ±3 and is normally distributed. Thus, no attempt was made to treat the data and we can go for further analysis.

5.2.6 Non-Response Bias Assessment

Obtaining a good response rate is important to ensure that data collected is a representative sample of the population, and to minimise the impact of non-response bias (Saunders et al., 2012). Even with high response rates, non-response bias could happen when the respondents' group differ from non-respondents (Armstrong and Overton, 1977).

Non-response bias happens when respondents refuse to answer survey questions partially or completely (Saunders et al., 2012), reducing the sample size, or when those who respond are different from those who do not respond (Voogt and Saris, 2005; Armstrong and Overton, 1977), which affects the validity of the survey and, in turn, produces biased results (Saunders et al., 2012), and hinders the ability to make generalizations (Hair et al., 2010).

In this research, refusal non-response bias should not be the case, as a high response rate was achieved for the paper-based questionnaire, 71.6%, and a satisfactory response rate of 20.3% for the online questionnaire. In total, the responses received from both modes of data collection were 40.5%, which is considered a good response rate. Additionally, non-complete responses with more than 20% of data missing were excluded from this study.

To test the differences between respondent and non-respondent groups, the researcher followed the technique recommended by Armstrong and Overton (1977) using the t-test. In this technique, an attempt was made to assess the statistical significance between early and late respondents. The first 50 responses received in May were considered as early respondents and the last 50 received in June were considered as late respondents. Table 5.30 shows the results of the assessment.

Constructs	Early Response Mean N=50	Late Response Mean N=50	Sig. p-value
Technical System Quality	4.3400	4.2250	.541
Information Quality	4.3721	3.7086	.490
Service Quality	3.5800	3.6280	.248
Educational System Quality	3.9600	3.5850	.396
Support System Quality	3.5350	3.5500	.799
Learner Quality	4.0080	4.0760	.155
Instructor Quality	3.9800	3.8560	.539
Perceived Satisfaction	3.6836	3.6500	.192
Perceived Usefulness	4.0800	3.9850	.442
System Use	4.5050	3.5970	.132
Benefits	3.9808	3.9640	.620

Table 5.30: Assessment of non-response bias between early and late respondents using t-test

The results of the assessment presented in Table 5.30 show there was no significant differences between the early and late respondents. All *p*-values retrieved were greater than 0.05 (i.e., insignificant). The mean was approximately the same. Therefore, non-response bias assessment results were not a concern in this research.

The use of mixed mode surveys improves the response rate and reduces non-response bias (Voogt and Saris, 2005). Nevertheless, the researcher attempted to measure any significant difference between the two groups (i.e., online and offline). The t-test was also used to detect any difference. Results are shown in Table 5.31. The mean values were approximately the same for both modes of data collection for each item. The *p*-values retrieved for all items were > .05 indicating no significant difference between the two groups as shown in the table below.

Constructs	Online Response Mean N=50	Paper Response Mean N=50	Sig. p-value
Technical System Quality	4.4018	4.2800	.613
Information Quality	4.3743	3.8771	.523
Service Quality	3.9680	3.4720	.755
Educational System Quality	4.2900	3.8750	.836
Support System Quality	3.8100	3.3850	.852
Learner Quality	4.5920	4.1880	.512
Instructor Quality	4.2400	3.8240	.768
Perceived Satisfaction	4.0200	4.0350	.952
Perceived Usefulness	4.4850	3.9950	.418
System Use	4.8350	4.1950	.717
Benefits	4.3120	3.7080	.879

Table 5.31: Assessment of differences between online and paper responses using t-test

5.2.7 Common Method Variance (CMV)

Common method variance or common method bias (CMB) can be found in self-report questionnaires collecting data on both independent and dependent variables at the same time from the same participants. The bias exists in the instrument rather than respondents; thus the instrument produces variances which will affect the analysis and can inflate or deflate relationships among variables and consequently produces unsound results that will be contaminated by the noise caused by the biased instrument. In the study conducted by Jakobsen and Jensen (2015) they stated:

> "Surveys often provide the information used to measure both the independent and dependent variables of an analysis. However, in such cases, the estimated effect of one variable on another is at risk of being biased because of common method variance; that is, systematic variance shared among the variables, which is introduced to the measures by the measurement method rather than the theoretical constructs the measures represent"

Different sources for common method bias exist. The common method bias describes the measurement error that is compounded by the sociability of respondents who want to provide positive answers (Chang et al., 2010), measurement characteristics such as complexity and ambiguity of instrument's items, instrument context, for example, the time and location of measurement, measurement medium, and context (e.g., context induced mood) (Podsakoff et al., 2012).

The researcher took into consideration procedural measures suggested by Podsakoff et al. (2012) to reduce bias by collecting data from different sources (students enrolled in various modules via Moodle); respondents anonymity; use of temporal and methodological separation of measurement by using two modes of collection (online and offline) over a two month period; and simplifying the measurement scale used by using 5-point Likert scale which gives respondents less variation and confusion.

The researcher also used statistical approaches to test the CMB by running the widely used Harman's single factor test (Podsakoff et al., 2012). This test tries to tweak the factor analysis by loading all items (measuring the latent variables) into the factor analysis and constraining the number of factors to 1. If the total variance of a single factor is less than 50% then CMB does not affect the data and results. The rationale for this conclusion is that, if CMB exists then the unrotated factor analysis will show that one item accounts for the majority of the variances in the model (Podsakoff et al., 2012).

SPSS was used to run the Harman's single factor score. The variance explained by a single factor was 30%. Table 5.32 shows the results.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	18.642	32.141	32.141	18.642	32.141	32.141
2	3.659	6.309	38.449			
3	2.535	4.371	42.821			
4	2.188	3.773	46.593			
5	1.910	3.293	49.887			
6	1.746	3.011	52.897			
7	1.502	2.590	55.487			
8	1.210	2.086	57.573			
9	1.139	1.964	59.537			
10	1.095	1.887	61.425			
11	1.084	1.869	63.294			
12	1.081	1.863	65.157			
13	.970	1.672	66.829			
14	.947	1.632	68.461			
15	.865	1.491	69.952			
16	.852	1.469	71.421			
17	.817	1.408	72.829			
18	.770	1.328	74.156			
19	.750	1.293	75.449			
20	.702	1.210	76.659			
21	.687	1.185	77.844			
22	.653	1.127	78.970			
23	.639	1.102	80.072			
24	.585	1.009	81.081			
25	.577	.994	82.075			
26	.551	.949	83.024			
27	.526	.906	83.931			
28	.500	.862	84.792			
29	.478	.824	85.616			
30	.472	.814	86.430			
31	.461	.795	87.225			
32	.449	.775	88.000			
33	.431	.743	88.743			
34	.416	.716	89.460			
35	.408	.704	90.163			
36	.377	.650	90.813			
37	.369	.636	91.449			
38	.363	.625	92.074			
39	.351	.605	92.679			
40	.335	.577	93.256			
41	.324	.559	93.815			
42	.300	.518	94.333			
43	.294	.507	94.840			
44	.284	.489	95.329			
45	.271	.467	95.796			
46	.265	.456	96.252			
47	.236	.407	96.659			
48	.225	.387	97.047			
49	.218	.375	97.422			
50	.209	.360	97.783			
51	.200	.345	98.127			
52	.198	.342	98.469			
53	.184	.318	98.787			
54	.173	.298	99.084			
55	.154	.266	99.350			
56	.138	.238	99.588			
57	.127	.218	99.806			
58	.113	.194	100.000			

The 30% variance explained by a single factor shows that CBM does not affect our results. The cut-off point is less than 50%

Table 5.32: SPSS output for Factor Analysis using a Single Factor

5.3 Descriptive Statistics of Demographic Data

This section summarizes and describes the data and the demographic information such as gender, age, nature of use, number of courses enrolled in, education level in a simple and understandable manner. The total completed responses used for the statistical analysis were 563 questionnaires after screening and removing missing data.

A. Age

The frequency and percent of the range of ages for the respondents are shown in Table 5.33 and Figure 5.29.

		Frequency	Percent
Valid	<21 years	331	58.8
	21-30 years	218	38.7
	>30 years	14	2.5
	Total	563	100.0

Table 5.33: Descriptive Statistics of Age for the Survey Respondent

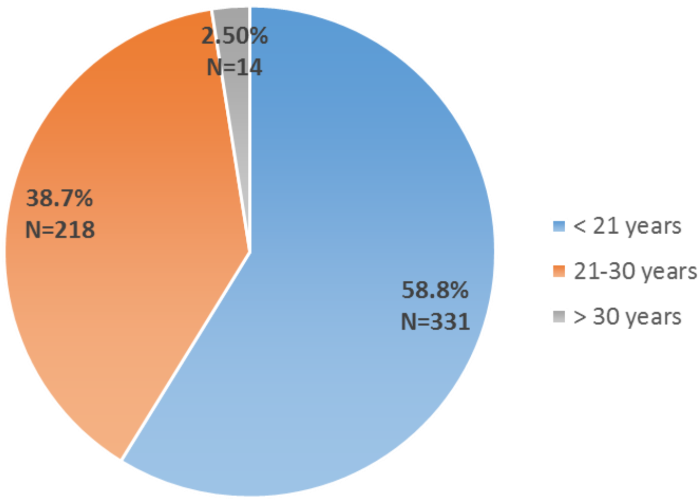


Figure 5.29: Age of Respondents

As shown in Table 5.33 and Figure 5.29, the range of ages for the majority of the students was less than 21 years old (N=331), forming 58.8% of the whole sample. This was followed by a range of between 21 and 30 years old (N=218) with 38.7% and only 14 respondents were older than 30 years with 2.5%.

B. Gender

The percentages of male and female students, as can be seen from Figure 5.30 below, shows 54% of female students (N=304) and 46% male students (N=259). The sample mirrored the University of Warwick students population in terms of gender (refer to Table 4.10, chapter 4).

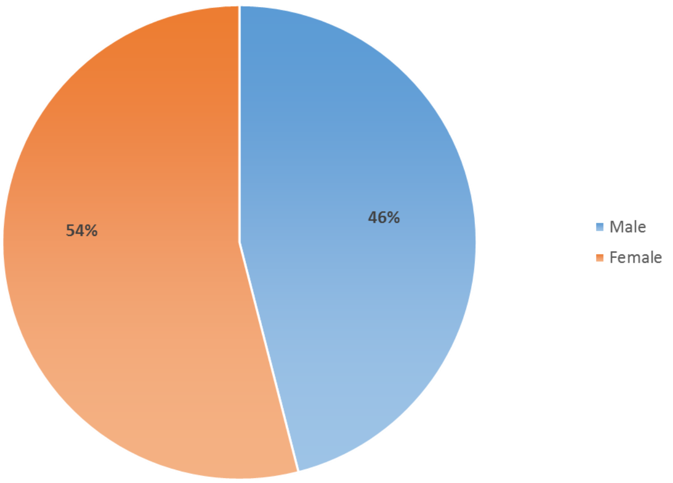


Figure 5.30: Gender of Respondents

C. Enrolled course

From the educational level perspective, most of the respondents were undergraduate students comprising 87.9%. Postgraduate students were 12%, with 68 respondents from the total sample as shown in Figure 5.31 below. The sample was skewed towards undergraduate students (the undergraduate students at the University of Warwick form 64% of the student population and 36% are postgraduate).

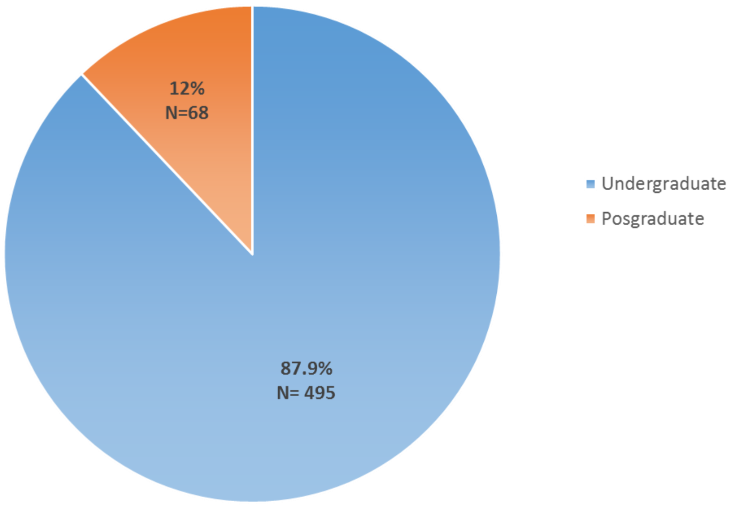


Figure 5.31: Education Level of Respondents

D. Number of enrolled modules via Moodle

The students were asked 'How many modules have you been enrolled in via Moodle?' The frequency and percentage of the number of modules delivered to students using Moodle are presented in Figure 5.32. The results reveal that the vast majority of the students (N=531) have been enrolled on more than one module during their academic study via Moodle.

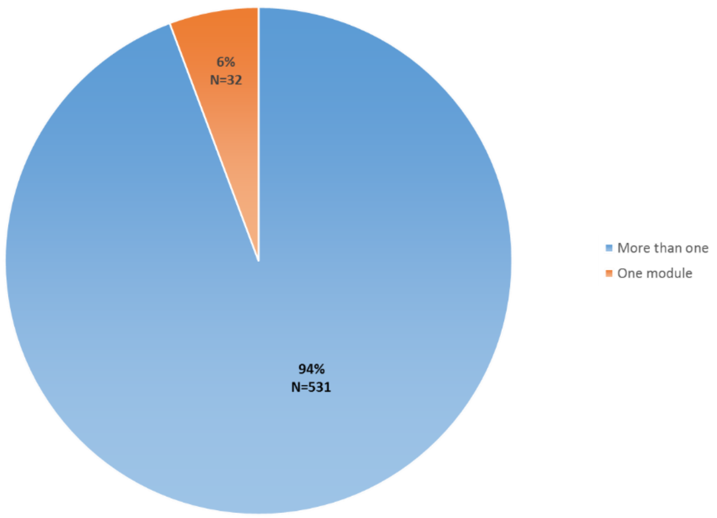


Figure 5.32: Number of Modules Delivered using Moodle

E. Experience with Moodle

Looking at Figure 5.33, it is apparent that students are experienced in using Moodle, with approximately 52% who have been using Moodle for more than 2 years. The rest of respondents have between 1 to 2 years of experience, and less than one year, with percentages of 23.6% and 24.7% respectively.

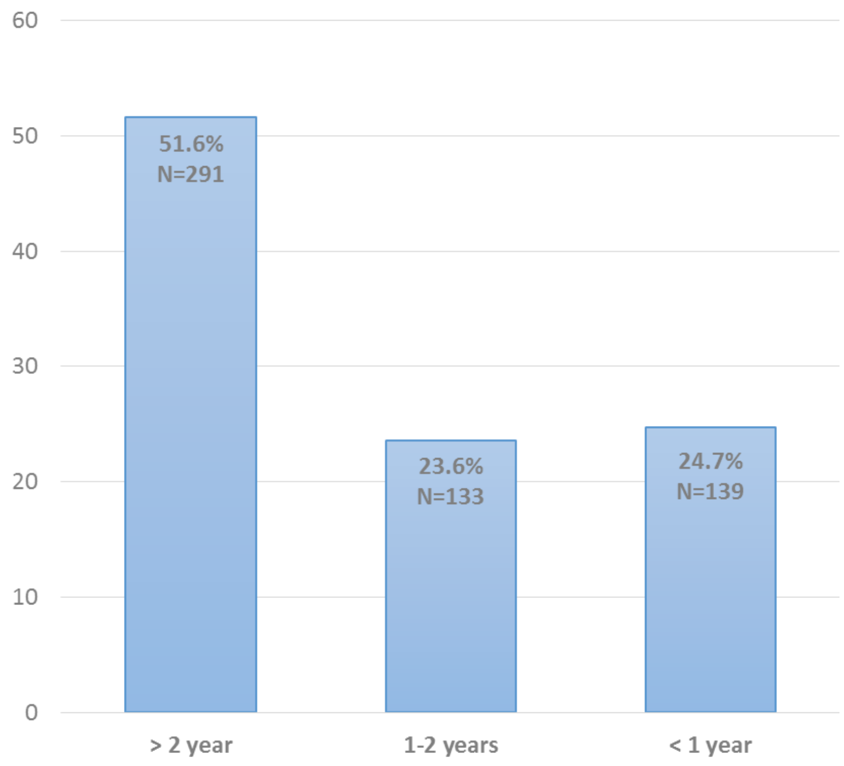


Figure 5.33: Experience with Moodle

F. Field of study

Within our sample, 253 respondents were students from the Faculty of Science and Engineering accounting for approximately 45%. Faculty of Social Sciences came next, with 222 respondents (39.43%) and the lowest with 15.63% were the Faculty of Medicine with 88 respondent (Figure 5.34).

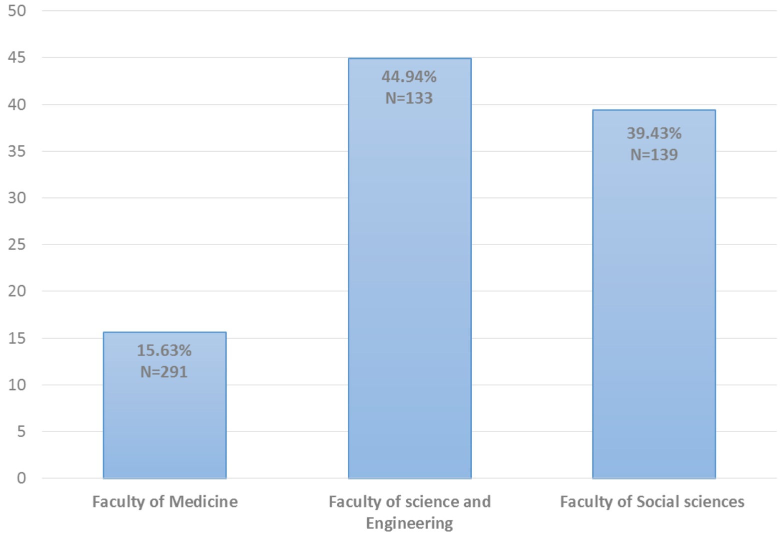


Figure 5.34: Field of Study

F. Nature of using Moodle

Students were asked about the way they used Moodle (Table 5.34). Half of the respondents used Moodle for both accessing learning resources and accomplishing and submitting assignments and quizzes, 27% of students used Moodle for the former purposes plus interacting with the instructor and colleagues. Other respondents used Moodle for accessing learning resources and interaction purposes only (6.4%), while 89 students used Moodle to accessing learning resources only 15.8%. (Figure 5.35)

Nature of use	Frequency	Percent
Access learning resources only	89	15.8%
Access learning resources, and accomplish and submit assignments or quizzes only	285	50.6%
Access learning resources, and interact with my instructors and colleagues only	36	6.4%
Access learning resources, accomplish and submit assignments or quizzes, and interact with my instructors and colleagues	153	27.2%
Total	563	100%

Table 5.34: Descriptive Statistics of Students' Nature of using Moodle

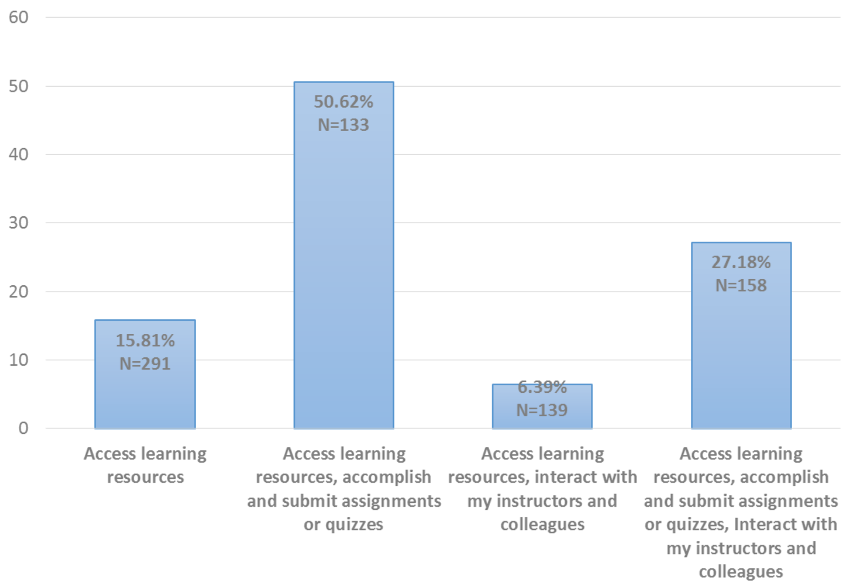


Figure 5.35: Nature of using Moodle

Respondents were left a space for expressing their ideas about any other uses of Moodle. Some students added that they also used Moodle to find timetables, receive announcements, and receive grades and feedback.

5.4 Descriptive Statistics of Constructs

This section presents the descriptive statistics of the model constructs. The scale used in the survey was five-point Likert scale: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree. The sample size was 563. Mean and standard deviation are the main statistical indicators used to describe the data in this section. Generally, all means were greater than 3.02 and less than 4.43. The standard deviation values indicated that these values were close to the mean. The values of mean and standard deviation generally show a positive response to the constructs of the study model.

1. Technical System Quality (TSQ)

The TSQ construct was operationalised in the study model to extract students' opinions about the desired characteristics and technical features of the Moodle LMS system. Eleven factors were employed to assess this construct. The descriptive indicators are shown in Table 5.35. The results show that the mean for the items related to TSQ range between 3.59 (SD= 0.952) and 4.17 (SD= 0.769). It appears that respondents of the survey have a positive attitude toward the technical quality issues of Moodle LMS. The lowest scores were for the flexibility of Moodle and consistency and integration of components within Moodle.

Items	Factors	Mean	Std. Deviation
TSQ1	Ease of Use	4.17	.769
TSQ2	Ease to Learn	4.02	.954
TSQ3	Users' Requirements	4.04	.667
TSQ4	System Features	3.93	.816
TSQ5	System Availability	3.92	.875
TSQ6	Flexibility	3.67	.897
TSQ7	Integration	3.59	.952
TSQ8	Reliability	4.09	.798
TSQ9	Fulfilment	4.16	.825
TSQ10	Security	4.09	.747
TSQ11	Personalization	4.12	.907

Table 5.35: Descriptive Statistics of TSQ

2. Information Quality (INQ)

This construct is operationalized to capture students' opinions about the desired characteristics and features of the content and information in Moodle LMS. Seven items were used to gauge this construct. The descriptive indicators are shown in Table 5.36. The mean values for the items vary between 3.64 and 4.00. The highest mean was for the usability of information (mean= 4.00) and the lowest was for the content design quality.

Items	Factors	Mean	Std. Deviation
INQ1	Sufficiency	3.99	.719
INQ2	Accessibility	3.90	.910
INQ3	Usability	4.00	.798
INQ4	Conciseness	3.85	.822
INQ5	Understandability	3.75	1.001
INQ6	Up to date content	3.76	.927
INQ7	Content design quality	3.64	1.108

Table 5.36: Descriptive Statistics of INQ

3. Service Quality (SRQ)

The service quality dimension is related to IT personnel staff and measures interactions on attributes such as providing guidance services to users, availability of staff, responsiveness, competency, and availability between students and services personnel responsible for the support of Moodle LMS. Descriptive data are shown in Table 5.37.

Items	Factors	Mean	Std. Deviation
SRQ1	Providing guidance services	3.26	.950
SRQ2	Providing help	3.02	.811
SRQ3	Staff availability	3.06	.805
SRQ4	Fair understanding	3.20	.842
SRQ4	Responsiveness	3.21	.702

Table 5.37: Descriptive Statistics of SRQ

4. Educational System Quality (ESQ)

This construct is employed in our model to assess the educational features of Moodle LMS that facilitate and improve conductive learning environment. Four items were employed to measure this construct. As shown in Table 5.38 the highest mean score was for effective communication, followed by the diversity of learning styles. From the descriptive data of demographic information (refer to Table 5.34), 50% of the respondents use Moodle both for accessing learning materials and submitting assignments and quizzes (assessment materials) and 27% use Moodle for the same purposes in addition to interact with instructors and colleagues.

Items	Factors	Mean	Std. Deviation
ESQ1	Interactivity features	3.42	.896
ESQ2	Effective communication	3.87	1.276
ESQ3	Diversity of learning styles	3.78	1.152
ESQ4	Assessment materials	3.69	1.147

Table 5.38: Descriptive Statistics of ESQ

5. Support System Quality (SUP)

Four attributes were utilised to survey students' opinions about the supportive factors that have influence on students using the Moodle LMS. The supportive issues include ethical and legal factors such as plagiarism policy when submitting assignments, and copyright and intellectual property rights during the preparation of e-learning materials. The fourth item was employed to assess the popularity of the Moodle LMS that has influence on students. As shown in Table 5.39 the mean values were between 3.25 and 3.94.

Items	Factors	Mean	Std. Deviation
SUP1	Ethical issues	3.57	.891
SUP2	Behavioural considerations	3.27	.895
SUP3	Legal issues	3.25	.920
SUP4	Promotion of the e-learning system	3.94	.938

Table 5.39: Descriptive Statistics of SUP

6. Learner Quality (LER)

Learner characteristics such as attitude, previous experience, and learners' self-efficacy that influence the success and satisfaction of the Moodle LMS were surveyed. The mean and standard deviation values are shown in Table 5.40. Responses from students toward this dimension show positive attitudes toward Moodle LMS, their previous experience and the ability to perform tasks in Moodle successfully (self-efficacy). Table 5.40 shows that the mean values range between 3.81 and 4.20.

Items	Factors	Mean	Std. Deviation
LER1	Learner's behaviour	4.15	.758
LER2	Learner's attitude	4.06	.850
LER3	Learner's anxiety	4.20	.798
LER4	Learner's previous experience	3.81	.943
LER5	Learner's self-efficacy	4.19	.693

Table 5.40: Descriptive Statistics of LER

7. Instructor Quality (INS)

The quality of the instructor in aspects such as enthusiasm and attitude toward using Moodle, responsiveness to questions, and interaction with students is an important dimension for the success of the Moodle LMS. Five attributes were employed to assess this construct. Based on the attributes' means, students showed high agreement about using Moodle based on the recommendation of the instructor (mean=3.94) while instructors' enthusiasm INS2 "*I think an instructor's enthusiasm about using Moodle in teaching stimulates my desire to learn*" received the lowest mean (mean= 3.45). The means of instructor's items ranged between 3.45 and 4.01 as shown in Table 5.41.

Items	Factors	Mean	Std. Deviation
INS1	Subjective norm	3.94	.832
INS2	Instructor's enthusiasm	3.45	1.007
INS3	Instructor's responsiveness	4.01	.876
INS4	Instructor's interactive communication	3.89	.902
INS5	Instructor's attitude	3.75	.895

Table 5.41: Descriptive Statistics of INS

8. Perceived Satisfaction (SAT)

Satisfaction was selected as a central construct in the study model and considered an inevitable measurement for the Moodle LMS success. Students' attitude and satisfaction toward Moodle LMS were surveyed using four items; satisfaction with system performance, enjoyable experience; providing educational needs and overall satisfaction. The means of these items were between 3.83 and 4.23, as shown in Table 5.42 below.

Items	Factors	Mean	Std. Deviation
SAT1	Satisfaction with system's performance	4.23	.630
SAT2	Enjoyable experience	3.83	.985
SAT3	Providing educational needs	3.92	.979
SAT4	Overall satisfaction	4.06	.858

Table 5.42: Descriptive Statistics of SAT

9. Perceived Usefulness (USF)

The role of the Moodle LMS in improving students' learning performance (usefulness) was assessed using four attributes. Students showed agreement about the usefulness of Moodle LMS such as accomplishing learning tasks quickly, improving their learning performance, and effectiveness of learning. Students tended to agree on the overall usefulness of Moodle LMS with mean = 4.23. The descriptive statistics are shown in Table 5.43.

Items	Factors	Mean	Std. Deviation
USF1	Accomplishing tasks quickly	3.83	.970
USF2	Improving learning performance	3.81	.930
USF3	Effective learning	3.83	.919
USF4	Overall usefulness	4.23	.744

Table 5.43: Descriptive Statistics of USF

10. System Use (USE)

The overall actual usage of the Moodle LMS was measured with 4 items: frequency of using the system, dependence on the system, regular use, and duration of using the system. Duration of using Moodle shows higher standard deviation value than the other items indicating that students have different opinions that are spread out over a wide range of values. Mean values for the first three items were nearly the same, the least mean value being 3.77 for the duration of using Moodle. Table 5.44 demonstrates the results.

Items	Factors	Mean	Std. Deviation
USE1	Frequency of use	4.43	.856
USE2	Dependence on system	4.28	.993
USE3	Regular use	4.33	.978
USE4	Duration of use	3.77	1.203

Table 5.44: Descriptive Statistics of USE

11. Benefits (BNT)

The impact of using the Moodle LMS on students (Benefits) was assessed using five attributes. The attributes were: increasing the knowledge, improving the learning process, easier communication and interaction, saving time and cost, and achieving the learning goals of the module. The descriptive statistics for this construct are presented in Table 5.45. The standard deviation for BNT3 '*Moodle makes communication easier with the instructor and other class mates*' shows a higher standard deviation (SD= 1.017, mean= 3.30). This is believed to be normal because some students do not use the communication and interaction facilities in Moodle. The highest mean was 3.91 for BNT4 (time and cost saving). One student added for example, 'the existence of course materials via Moodle helps me to keep the material efficiently without losing the information and saves the costs of printing them'.

Items	Factors	Mean	Std. Deviation
BNT1	Increased knowledge	3.88	.874
BNT2	Improved learning process	3.84	.914
BNT3	Easier interaction and communication	3.30	1.017
BNT4	Time and cost saving	3.91	.980
BNT5	Achieving learning goals	3.85	.849

Table 5.45: Descriptive Statistics of USE

5.5 Chapter Summary

This chapter provided details of the procedures followed to prepare and examine the data, and methods used for handling missing data and outliers. Also, the techniques followed to account for non-response and common method bias were presented. Using the SPSS version 24 software package, descriptive data about respondents' profiles were presented. Also, the descriptive statistical reports for each construct were displayed. The next chapter shows further analysis to test the measurement and structural model using SmartPLS.

CHAPTER SIX: MODEL TESTING

6.1 Chapter Introduction

This chapter is allocated to testing the study model. It is organized into two main sections. Section 2 is the methodology used for testing the model and section 3 introduces the results obtained from the analysis. PLS-SEM is utilized as a key technique to analyse the quantitative data, test the model and examine the hypotheses. Furthermore, content analysis is used to analyse the qualitative part received from the open-ended question in the survey. In section 2, the methodology is divided into three parts: the measurement model methodology, the structural model methodology, and content analysis of students' comments methodology. In section 3, the results are introduced for each of the three parts: measurement model assessment results, structural model assessment results and content analysis of students' comments results respectively.

6.2 Model Testing Methodology

Researchers use different statistical methods to develop and confirm their research findings. Hair et al. (2016) distinguished between two generations of the application of statistical methods. Factor analysis and regression analysis were predominant and extensively used in the first generation. There has been a shift since the 1990s toward more sophisticated multivariate methods such as structural equation modelling (SEM) which has dominated the research landscape in the second generation.

SEM is not a single technique, but "a general modelling framework that integrates a number of different multivariate techniques into this overall framework. It brings together measurement theory from psychology, factor analysis from psychology and statistics, path analysis from epidemiology and biology, regression modelling from statistics and simultaneous equations from econometrics, and all these different techniques come together to form structural equation modelling as a general modelling environment" (Sturgis, 2016). SEM is widely used to develop and test theoretical models to overcome the obstacles of first generation methods where researchers are interested in systems of relationship and more complex and multifaceted constructs, rather than a dependent variable and a set of predictors, or the effect of one or several independent variables on one dependent variable as in the case of fitting regression models (Sturgis, 2016). SEM is particularly useful for accounting and correcting for measurement error terms that are associated with observed variables (Sturgis, 2016). Moreover, SEM is very suitable in modelling causal systems and in situations where researchers have indirect and mediated effect. In addition, SEM is ideal in situations where answers to interrelated research questions are required at different levels in a single, systematic, and comprehensive analysis (Gefen et al., 2000).

There are two types of SEM, covariance-based SEM (CB-SEM) and composite-based SEM known as partial least squares SEM (PLS-SEM). Hair et al. (2016) stated that CB-SEM is suitable in situations where the objective of the research is to confirm or reject a well-developed theoretical model (theory testing) by determining how well the model can estimate the variance-covariance matrix for the data sample. On the other hand, the composite-based SEM is suitable to develop theories in exploratory research by explaining the variance in the dependent variables when examining the theoretical model (Hair et al., 2016).

In this research, the researcher used PLS-SEM as a key technique to test the study model and examine the hypotheses. The justifications for using it in this study are as follows.

1. PLS-SEM is suitable in situations where theory is less developed (Urbach and Ahlemann, 2010; Hair et al., 2016) which fits the purpose of this study. The goal of this research is to extend an existing theory (i.e. Delone and McLean information systems success theoretical model) and to explore whether the additional constructs are valuable for extending the theory being tested rather than confirming it (Hair et al., 2016).
2. To explore the relationships (if any) between the variables in the model and test the hypotheses (Hair et al., 2016).
3. To predict the key driver constructs for the success of e-learning systems (Hair et al., 2016) and PLS-SEM is ideal in predicting and explaining the target constructs (Hair et al., 2016).
4. The suggested model in this study could be a complicated model due to the number of constructs (dependent and independent variables) and the number of relationships among them: 11 constructs, 58 indicators, and 26 relationships and PLS-SEM fits such kind of models (Hair et al., 2016).
5. PLS-SEM has been widely used in the context of information systems and e-learning, allowing the researcher to compare the results of testing the model with other studies.

SmartPLS version 3.2.8 software is utilised for the data analysis to test the model variables and hypotheses. Two sub-models emerge in PLS-SEM: the measurement model and the structural model. The measurement model is the outer model which specifies how each of the latent variables is measured (i.e. constructs). The latent variables in the model are unobservable variables that cannot be measured directly, but rather indirectly using the observed indicators (i.e. manifest variables). In contrast, the structural model specifies the sequence of constructs and the relationships between the latent variables and how they are related to each other (the inner model). The structural model represents the research hypotheses and the relationships to the theory being tested (Hair et al., 2016).

6.2.1 Measurement Model Assessment Methodology

The model of the study comprises 11 latent variables and 58 indicators employed to measure these latent variables. The measurement model in this study consists of measures (indicators) that represent the effects (or manifestations) of the underlying construct. Following the guidelines suggested by Hair et al. (2016) the criteria used for the measurement model assessment are summarized as follows.

Step1: Indicator Reliability

Indicator reliability measures how much of the indicator's variance is explained by the corresponding latent variable (Urbach and Ahlemann, 2010). Hair et al. (2016) stated that at least 50% of each indicator's variance should be accounted for by the underlying construct, and the outer loading should be larger than the rule of thumb 0.70 to indicate a reliable indicator for a specific construct.

Step2: Internal Consistency Reliability

Internal consistency is a term used for estimating the reliability of a measure by evaluating the within-scale consistency of the responses to the items of the measure. Cronbach's α is a common measure widely used to test the internal consistency. It assumes that all observed indicators are related equally to the construct. It varies from 0 to 1. Researchers consider as a rule of thumb that values of α greater than 0.70 are required for well-established constructs to judge the reliability (Garson, 2012). The only issue with Cronbach's α is that it increases with the number of indicators in the scale. To address this, Hair et al. (2016) suggest reporting the composite reliability. Composite reliability does not assume the indicators are related equally (as Cronbach's α) but considers the varying factor loadings of the items. They suggest reporting Cronbach's α as the lower bound and the composite reliability the upper bound of the true internal consistency reliability. The same cut-off values for composite reliability would be as for Cronbach's α.

Step3: Construct Validity

There are two subcategories of construct validity, namely convergent and discriminant validity.

To distinguish between them, convergent validity refers to the degree to which two measures of construct that should be related theoretically are related (also called construct communality). In other words, the convergent validity exists when we need to show a correspondence or convergence between similar constructs. Hair et al. (2016) suggested using the Fornell and Larcker (1981) method of average variance extracted (AVE) to assess the convergent validity. The AVE is "a measure of the amount of variance that is captured by a construct in relation to the amount of variance due to measurement error" (Fornell and Larcker, 1981). In other words, a higher value of AVE is a good indication that the construct well characterizes what is intended to measure. The recommended cut off value is AVE ≥ 0.50

On the other hand, discriminant validity shows how two dissimilar constructs are in fact not related to each other. The discriminant validity is critical for model validation. It tests that a construct does not correlate too highly with constructs from which it is supposed to differ. Farrell (2010, p.324) mentioned, "If discriminant validity is not established, then conclusions made regarding relationships between constructs under investigation may be incorrect. For example, the strength of a relationship could be overestimated, or a relationship may be confirmed when in fact there is no real relationship".

Three techniques are used in this study to test the discriminant validity. First, the traditional Fornell and Larcker (1981) technique shows discriminant validity if the construct better explains the variance of its own indicators than the variance of the other constructs. It does so by comparing the AVE of the construct with the square root of correlations ($\sqrt{\text{AVE}}$) between the construct and all other constructs. The AVE should be higher in the same construct compared to $\sqrt{\text{AVE}}$ with other constructs. In this study, the correlation matrix with the square root of AVE and the results of the comparison will be reported for the discriminant validity test.

Second, the cross loadings are also used to check for discriminant validity. In this technique, each indicator should load highest on the construct it is associated with. The results of indicators' cross loading will also be reported in this study.

In the study conducted by Henseler et al., (2015) it was found that both the Fornell and Larcker criteria and cross loadings are insufficiently sensitive to detect many discriminant validity problems. A new criterion was proposed in their paper for discriminant validity assessment that is the Heterotrait-Monotrait ratio (HTMT), which is equal to average Heterotrait-Heteromethod correlation relative to the average Monotrait-Heteromethod correlations. The Heterotrait-Heteromethod correlations are correlation of indicators across constructs measuring different phenomena, while the Monotrait-Heteromethod correlations are correlations of indicators measuring the same construct. According to the authors “HTMT can be used to assess the discriminant validity as a criterion which involves comparing it to a predefined threshold. If the value of the HTMT is higher than this threshold, one can conclude that there is a lack of discriminant validity”. The threshold level of the HTMT proposed in this study is a value of 0.90, according to Henseler et al., (2015). Table 6.46 summarizes the criteria used in this research for the measurement model assessment.

Criteria	Reliability		Validity				
	Internal Consistency Reliability		Indicator Reliability	Convergent Validity	Discriminant Validity		
Criterion	**Cronbach's alpha α**	**Composite Reliability CR**	**Indicator Loading**	**Average Variance Extracted AVE**	**Fornell-Larcker**	**Cross-loadings**	**HTMT**
Description	It is a measure of internal consistency, that is, how closely related a set of items are as a group	It is a measure of the sum of a variable's factor loadings relative to the sum of the factor loadings plus error variance	It is a measure of how much of the indicators' variance is explained by the corresponding LV	It is a measure of the amount of variance that an LV component captures from its indicators relative to the total variance with measurement error	It requires an LV to share more variance with its assigned indicators than with any other LV	Loading obtained by correlation the component scores of each latent variable with all other items	It is the average of correlations of indicators across constructs measuring different phenomena relative to the average of correlation of indicators measuring the same construct
Threshold value	$\alpha \geq 0.70$	$CR \geq 0.70$	Loading ≥ 0.70 or ≥ 0.40 & has no impact on AVE and CR	$AVE \geq 0.50$	The AVE of each latent variable should be greater than the LV's highest squared correlation with any other LV	If the loading of each indicator is higher for its designated construct than for any of the other constructs, and each of the constructs load highest with its own items then model's constructs differ from each other	$HTMT < 0.90$
Reference	Hair et al. (2016); Urbach and Ahlemann (2010)	Hair et al. (2016); Urbach and Ahlemann (2010)	Hair et al. (2016)	Fornell and Larcker (1981)	Fornell and Larcker (1981)	Urbach and Ahlemann, (2010)	Henseler et al. (2015)

Table 6.46: Summary of the criteria used for the assessment of the Measurement Model

6.2.2 Structural Model Assessment Methodology

Once we have established our constructs' measures in the measurement model and proved their reliability and validity, the next step is to assess the structural model or path model. The structural model is the second sub-model in PLS-SEM. It is a visual representation of the underlying structural theories/concepts of the path model. It specifies the sequence of the constructs and the relationships between the latent variables and how they are related to each other (the inner model). The structural model represents the research hypotheses and the relationship to the theory being tested. Moreover, assessment of the structural model allows us to determine the model's capability to predict one or more target constructs (Hair et al., 2016).

A systematic approach for the assessment of the structural model was proposed by Hair et al. (2016). Following their recommendations, the structural model assessment procedure used in this study is summarized in five steps as can be seen in Figure 6.36:

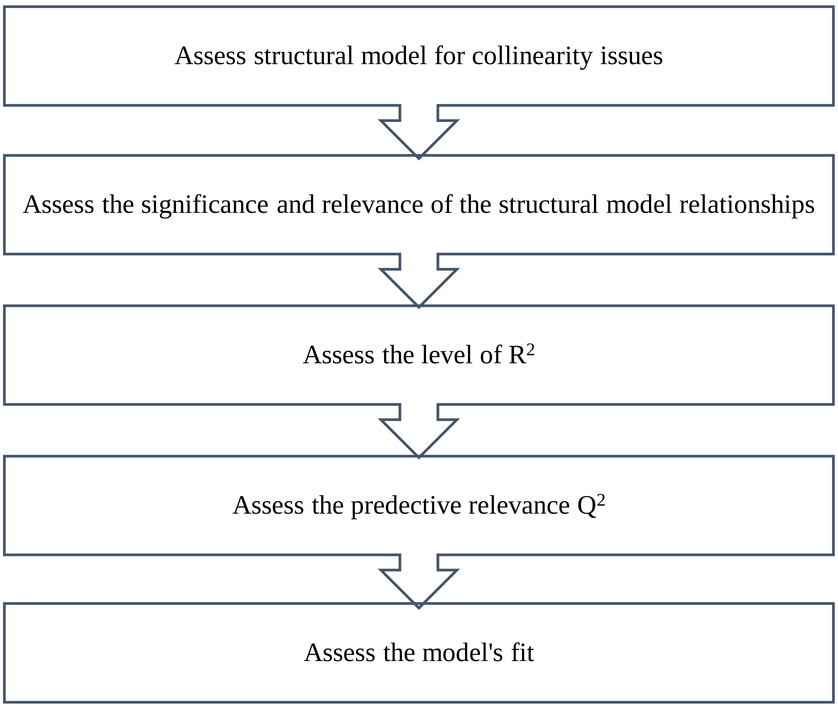


Figure 6.36: Structural Model Assessment Procedure

Step1. Collinearity

The first step is to examine if there is any collinearity. Collinearity refers to the correlation between the predictor variables (i.e., independent variables). It generally occurs when there are high correlations between them. In other words, a variable can be used to predict the other one resulting in redundant information, unstable regression estimates and skewing the results (Pallant, 2013). The rationale for starting with a collinearity check is that the estimation of path coefficients in the structural model depends on the regressions of each endogenous latent variable on its corresponding predecessor constructs. Thus, the existence of critical levels of collinearity among the predictor constructs causes the estimation of path coefficients to be biased (Hair et al., 2016).

An easy way to detect collinearity symptoms is by generating the variance inflation factor VIF. A VIF value ≥ 5 indicates a potential collinearity problem. Thus, the cut-off value used in this study for accepted collinearity level is VIF < 5 (Hair et al., 2016).

Step2. Structural Model Path Coefficients

Path coefficients (β) are obtained in this step for the assessment of the structural model to test the hypothesized relationships between the constructs. Each hypothesis represents a path in the structural model. Path coefficients represent the strengths of the relationships between the two constructs. The β values range between ±1. The closer the value to 1 the stronger the relationship is, and the closer the value to zero the weaker the relationship is.

In order to determine the significance of the relationships, we need a standard error estimation that is associated with observed variables by means of bootstrapping. Bootstrapping is "a resampling technique that draws a large number of sub-samples from the original data and estimates models for each subsample" (Hair et al., 2016). The bootstrapping procedure allows computing the *t* values and *p* values for all structural path coefficients. The *t* and *p* values are used to test whether the path coefficients (β values) are statistically significant at a certain error probability (i.e., significance level) for bootstrap samples. Common critical *t* values for one-tailed tests are 1.28, 1.65 and 2.33 for significance levels (i.e., *p* values) of 10%, 5% and 1% respectively (Hair et al., 2016). In other words, the *p* value is the probability of erroneously accepting the hypothesis (assuming there is a significant path coefficient). In this study 5000 bootstrap samples are generated as recommended by Hair et al. (2016). The statistical significance level used in this study is 5% following the majority of studies in information systems and e-learning domain (i.e., p value < 0.050 and t value > 1.65 to accept the hypothesis). The *p* and *t* values in this study were reported using a one-tailed test as recommended to use this type of test if the research hypotheses are positive (have + sign) (Kock, 2015).

Step3. Assessment of the Coefficient of Determination R^2 Value

Coefficient of determination R^2 is the most widely used measure in the assessment of the structural model. It is a measure of the model's predictive accuracy. The coefficient value is a representation of the amount of variance in the endogenous constructs explained by all of the exogenous constructs connected to it (Hair et al., 2016). As the name indicates, is the squared correlation of the actual values and the predictive values that have been used for model estimation to judge the model's predictive power (Sarstedt et al., 2014). The R^2 values are between 0 and 1 with higher values, generally, indicating higher levels of predictive power. There are arguments about the acceptable values of R^2, which is highly dependent on the context of the research and the complexity of the model being tested (Hair et al., 2016). For example, $R^2 = 0.25$ could be considered substantial in some disciplines but weak in others. Considering the context of e-learning in this research, the levels of R^2 suggested by Urbach and Ahlemann (2010) and Chin (1998) are used in this study: "Values of approximately .670 are considered substantial, values around .333 moderate, and values around .190 weak" (Urbach and Ahlemann, 2010).

Step4: Assessment of the Predictive Relevance Q^2

The coefficient of determination R^2 was the third step that has been employed as a criterion of predictive accuracy in the structural model assessment, nevertheless, Hair et al. (2016) stated that researchers should also assess the Stone-Geisser's Q^2 value. The predictive relevance Q^2 is "an indicator of the model's out-of-sample predictive power or predictive relevance" (Hair et al., 2016) which measures how well the observed values are reproduced by the path model. They added, "when a PLS path model exhibits predictive relevance, it accurately predicts data not used in the model estimation". Q^2 values greater than zero for a particular latent endogenous variable is an indication of the path model's predictive relevance (Fornell and Cha, 1994; Hair et al., 2016). In contrast, values of zero and below are an indication of a lack of predictive relevance.

The predictive relevance of Q^2 values are retrieved in SmartPLS using blindfolding for a specified omission distance D (rule of thumb: $5 \leq D \leq 10$). An omission distance of seven, for example, indicates that every seventh data point of the target construct's indicators are eliminated in a single blindfolding round (Hair et al., 2016). Blindfolding is "a sample reuse technique that omits every D^{th} data point in the endogenous construct's point" (Chin, 1998). Hair et al. (2016) stated "…the omitted data points are considered missing values and treated accordingly when running the PLS algorithm, the resulting estimates are then used to predict the omitted data point. The difference between the true (omitted) data points and the predicted ones is then used as input for Q^2 measure. Blindfolding is an iterative process that repeats until each data point has been omitted and the model re-estimated".

It is important to mention that two kinds of predictive relevance are generated with blindfolding, the cross-validated redundancy approach which builds on model estimates of both the structural and the measurement model, on the other hand, cross-validated communality uses only the measurement model (i.e., construct scores without structural model information) to predict the omitted data point (Hair et al., 2016). In this study values of Q^2 for both ways are reported. The cross-validated redundancy and cross-validated communality can be interpreted as suggested by Hair et al. (2016) as follows:

- $0.02 \leq Q^2 < 0.15$: weak predictive power;
- $0.15 \leq Q^2 < 0.35$: moderate predictive power;
- $Q^2 \geq 0.35$: strong predictive power.

Step5: Assessment of Model Fit

The last step after examining the predictive power of the model is to assess the model fit. Model fit addresses the issue of how well the model that best represents the data reflects the underlying theory (Hooper et al., 2008). In PLS-SEM, examples of model fit measures are the following measures:

1. Standardised Root Mean Square Residual (SRMR);
2. Root Mean Square Residual Covariance (RMS_{theta});
3. Normed Fit Index (NFI);
4. Chi square χ^2.

Sarstedt et al. (2017, p.13) stated that "the NFI is not usually recommended in PLS as it systematically improves for more complex models". Also, there exists a number of limitations regarding using the common χ^2 in PLS, for example, it needs a normal distribution and any severe deviation from normality may results in model rejection even when the model is properly specified. In addition, χ^2 is sensitive to sample size and may give misleading results, and as a result, not discriminating between good or poor fitting models (Hooper et al., 2008).

In this study, the SRMR and RMS_{theta} model fit measures will be reported as these are believed to be commonly used measures by researchers and recommended in the original studies in the PLS-SEM context.

It is worth mentioning that there is no global fit measure in PLS unlike the CB-SEM method. Hair et al. (2016) argued that it is inappropriate in PLS, and more research is needed to apply them appropriately. Overcoming this lack, researchers proposed a global criterion of goodness-of-fit (GoF) in PLS (Tenenhaus et al., 2005; Wetzels et al., 2009; Chin, 2010).

Based on this, the criteria used in the assessment of model fit in this study are: Standardised Root Mean Square Residual (SRMR), Root Mean Square Residual Covariance (RMS theta) and Goodness-of-Fit (GoF). More details are given about these measures.

1. Standardised Root Mean Square Residual (SRMR)

The SRMR is a measure used to assess the model's fit in PLS-SEM based on residuals (Henseler et al., 2014). A residual is "an error term which is created when the model does not fully represent the actual relationship between the independent variables and the dependent variables" (Silver et al., 2018). As a result of this incomplete relationship, the error term is the amount at which the equation may differ during empirical analysis. The SRMR is defined as "the difference between the observed correlation and the model implied correlation matrix" (Hair et al., 2016). Thus, the SRMR allows assessing the average magnitude of the discrepancies between observed and expected correlations as an absolute measure of (model) fit criterion. The cut off value below 0.10 or in a more conservative contexts below 0.08 shows a good fit of the model (Hair et al., 2016; Hooper et al., 2008).

2. Root Mean Square Residual Covariance (RMS_{theta})

The RMS_{theta} assesses "the degree to which the outer model residuals correlate" (Henseler et al., 2014). Thus, a value close to zero is an indication of good model fit, because it implies that very small correlations exist between the outer model residuals (close to zero) (Henseler et al., 2014). RMS_{theta} values below 0.12 indicate a well-fitting model, whereas higher values indicate a lack of fit (Henseler et al., 2014).

3. Goodness-of-Fit (GoF)

Goodness of fit is our last criterion to assess the overall fit of the model. It is defined as "how well the specified model reproduces the observed covariance matrix among the indicator items" (Hair et al., 2016). The purpose of GoF is to account on the model at both levels that is, the measurement model and the structural model with a focus on the overall performance (Henseler and Starstedt, 2013). As mentioned earlier, there is no global fit measure in PLS. Researchers suggest a global GoF defined as the geometric mean of the average communality and average R^2 for endogenous constructs (Tenenhaus et al., 2005) given using this formula:

$$\text{GoF}= \sqrt{\text{R2} * \text{average communality}}$$

The GoF cut off values used in this study are (Wetzels et al., 2009):

- GoF less than 0.1 No fit;
- GoF between 0.1 to 0.25 Small;
- GoF between 0.25 to 0.36 Medium;
- GoF greater than 0.36 Large.

Table 6.47 summarizes the criteria used to evaluate the structural model in this study.

Criterion	Description	Threshold value	Reference
Collinearity	Collinearity assesses the correlation between the predictor variables in the model. It generally occurs when there are high correlations between them, which means a variable can be used to predict the other one resulting in redundant information, unstable regressions estimates, and skewing the results. Collinearity can be detected using the variance inflation factor VIF	VIF < 5	Hair et al., 2016
Path coefficient β	The correlation between the latent variables should be analysed. The significance of hypothesised correlation can be assessed using bootstrapping	Significant if $p < 0.05$	Hair et al., 2016
Coefficient of Determination R^2	It is a measure of the explained variance of a latent variable relative to its total variance	$R^2 \leq 0.190$ weak $0.190 < R^2 \leq 0.333$ moderate $0.333 < R^2 < 0.670$ moderate to substantial $R^2 \geq 0.670$ substantial	Urbach and Ahlemann, 2010
Predictive relevance Q^2	It is a measure of the predictive relevance of a block of indicators. The higher Q^2 is the more predictive relevance the model is	$Q^2 > 0$	Cohen, 1988; Urbach and Ahlemann, 2010; Hair et al., 2016
Model Fit	1. Standardised Root Mean Square Residual (**SRMR**) is a measure used to assess the goodness of fit measure for PLS-SEM to assess the model fit based on residuals	SRMR < 0.08	Henseler et al., 2014; Hair et al., 2016
	2. Root Mean Square Residual Covariance (**RMS theta**) is "the degree to which the outer model residuals correlate"	RMS theta ≤ 0.12	Henseler et al., 2014; Hair et al., 2016
	3. Goodness-of-Fit (**GoF**) is defined as "how well the specified model reproduces the observed covariance matrix among the indicator items" (Hair et al., 2016). The purpose of GoF is to assesses the overall fit of the model and account on the model at both levels that is, the measurement model and the structural model with a focus on the overall performance	GoF < 0.1 no fit 0.1≤ GoF < 0.25 small 0.25 ≤ GoF < 0.36 medium GoF ≥ 0.36 large	Tenenhaus et al., 2005; Wetzels et al., 2009

Table 6.47: Summary of the criteria used for the assessment of the Structural Model

6.2.3 Content Analysis of Students' Comments Methodology

As stated earlier, an open-ended question was added in the questionnaire to elicit students' opinions about the e-learning system. Analysing these comments enables the main issues faced by students regarding the e-learning system to be identified and classified. Students' comments were analysed using content analysis. Content analysis is defined as a thematic analysis used to identify, analyse, report patterns (themes), and describe the data in detail (Braun and Clarke, 2006). Thematic analysis is one of the most straightforward and flexible methods to analyse qualitative data. Two methods are found in thematic analysis: an inductive approach and the deductive theoretical approach (Braun and Clarke, 2006). Table 6.48 below summarizes the differences between the two approaches.

Deductive Thematic Analysis	Inductive Thematic Analysis
Top down approach	Bottom up approach
Analyst driven	Data-driven
Themes are strongly related to the researcher's theoretical interest	Themes are strongly related to the data collected itself
Coding is based on pre-existing coding frame	Coding without pre-existing coding frame
Coding for a specific research question	The specific research question can evolve through coding process

Table 6.48: Differences between deductive and inductive thematic analysis

In this study, the deductive thematic analysis approach fits the purpose of the study, where the researcher codes based on pre-existing themes related to the theory being tested, around a specific research question: '*What are the factors that affect the success of e-learning systems?'*.

Thus, deductive thematic analysis is the methodology used in this part of the study to:

A) Capture the themes in relation to e-learning systems success factors;
B) Identify the most frequently occurring keywords from students' comments;
C) Recognize the issues faced by students.

The following basic steps will be followed as a guideline to conduct thematic analysis, as suggested by (Erlingsson and Brysiewicz, 2017; Braun and Clarke, 2006):

1. Read and re-read the text to familiarise oneself with the data;
2. Generate initial codes (an initial list of ideas about what is in the data and what is interesting about them);
3. Develop sub-themes by finding the words that capture the ideas in the codes;
4. Search for themes (which involves sorting the different sub-themes into themes, and collect all the relevant coded data within the identified themes); it might be helpful to use visual representations like mind-maps and cloud words to sort the different codes into themes;
5. Review the themes.

These steps were followed by the researcher to analyse each comment carefully. The themes emerged from comments were checked by two volunteers to check for alternative explanations and to review the results.

The results of content analysis of the themes can be quantified (quasi-quantification) to show the percentage and frequency of words under each theme and sub-theme (Bergman, 2010). This also includes dividing the direction of comments into positive and negative directions and describing the generated data, in addition to eliciting implicit and explicit issues faced by students using the e-learning system (Guest et al., 2011). As a result, content analysis is employed to recognize the main factors influencing the success of e-learning systems. Additionally, the content analysis results will assist in explaining and supporting the quantitative results.

6.3 Model Testing Results

6.3.1 Assessment of Measurement Model Results

The assessment results of the measurement model are presented in this section, followed by the structural model results. The model of the study comprises eleven latent variables and 58 indicators employed to measure these latent variables. The measurement model has been assessed using the following criteria.

Step1: Indicator Reliability: outer loading for the indicator should be ≥ 0.70

Step2: Internal Consistency Reliability: using two tests: Cronbach's alpha (α) and Composite reliability (CR). The cut off value is ≥ 0.70 for both tests.

Step3: Validity:

3.1 Convergent Validity: the average variance extracted AVE should be ≥ 0.50

3.2 Discriminant Validity: using three tests

3.2.1 Fornell-Larcker criterion;

3.2.2 Cross-loadings;

3.2.3 HTMT.

Step1: Indicator Reliability Results

The first criterion for assessing our measurement model is the reliability of the indicators. Hair et al. (2016) stated that at least 50% of each indicator's variance should be accounted for by the underlying construct and the outer loading should be larger than the rule of thumb 0.70 to indicate a reliable indicator for a specific construct. Using SmartPLS, the path model was built and the PLS algorithm was performed to obtain the estimations. The factor loadings for all the 58 indicators are summarized in Table 6.49 below.

#	Indicator	Factor Loading	#	Indicator	Factor Loading	#	Indicator	Factor Loading
1.	TSQ1	0.730	21.	SRQ3	0.900	41.	INS5	0.780
2.	TSQ2	0.040	22.	SRQ4	0.800	42.	SAT1	0.820
3.	TSQ3	0.750	23.	SRQ5	0.680	43.	SAT2	0.890
4.	TSQ4	0.760	24.	ESQ1	0.850	44.	SAT3	0.880
5.	TSQ5	0.510	25.	ESQ2	0.510	45.	SAT4	0.920
6.	TSQ6	0.710	26.	ESQ3	0.550	46.	USF1	0.850
7.	TSQ7	0.670	27.	ESQ4	0.880	47.	USF2	0.910
8.	TSQ8	0.610	28.	SUP1	0.700	48.	USF3	0.900
9.	TSQ9	0.570	29.	SUP2	0.750	49.	USF4	0.830
10.	TSQ10	0.440	30.	SUP3	0.790	50.	USE1	0.890
11.	TSQ11	0.410	31.	SUP4	0.800	51.	USE2	0.920
12.	INQ1	0.730	32.	LER1	0.880	52.	USE3	0.930
13.	INQ2	0.720	33.	LER2	0.890	53.	USE4	0.800
14.	INQ3	0.820	34.	LER3	0.800	54.	BNT1	0.830
15.	INQ4	0.840	35.	LER4	0.460	55.	BNT2	0.860
16.	INQ5	0.780	36.	LER5	0.820	56.	BNT3	0.600
17.	INQ6	0.650	37.	INS1	0.630	57.	BNT4	0.760
18.	INQ7	0.650	38.	INS2	0.690	58.	BNT5	0.830
19.	SRQ1	0.760	39.	INS3	0.840			
20.	SRQ2	0.810	40.	INS4	0.570			

Table 6.49: Indicators' factor loadings

By observing the loading coefficient, items with loadings above 0.70 were kept; items with factor loadings below 0.70 were highlighted (17 items). The technique used to deal with them was based on the suggestion of Hair et al. (2016) which is summarized in Figure 6.37.

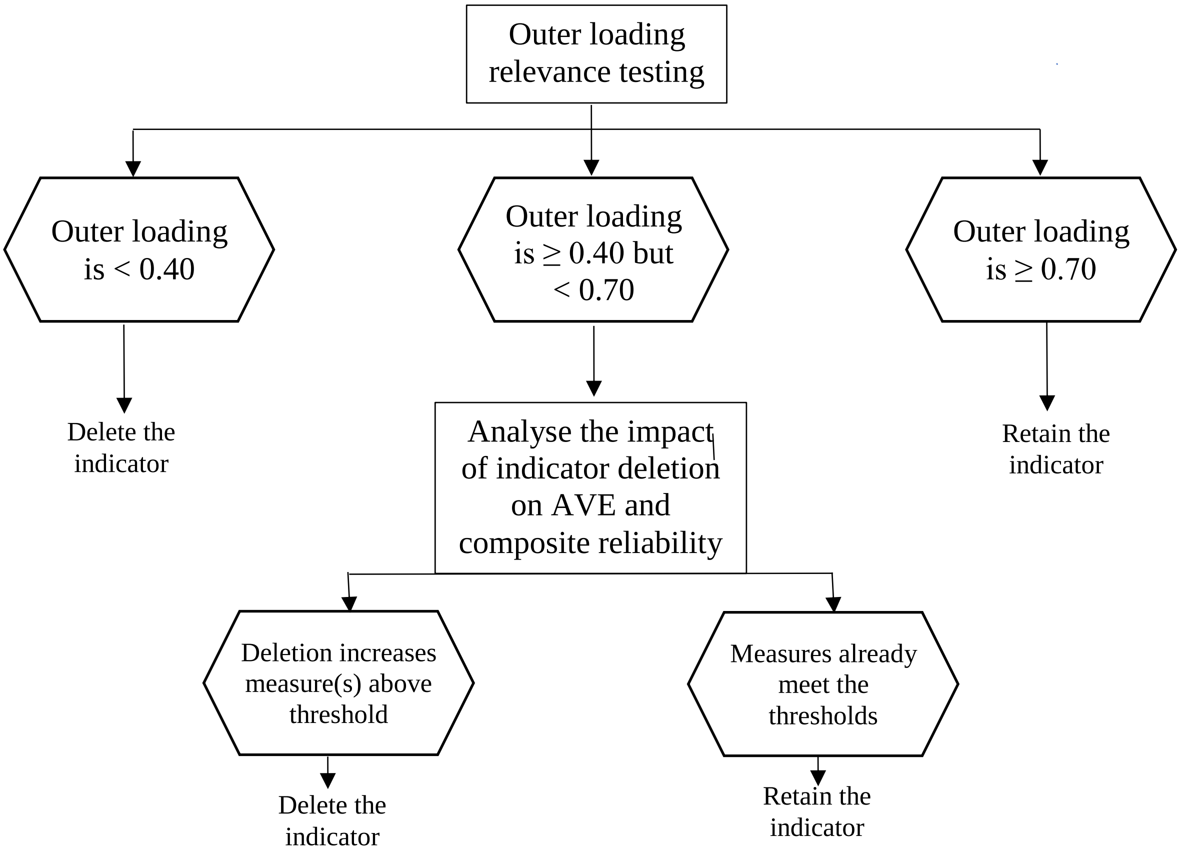


Figure 6.37: Outer loading relevance testing (Hair et al., 2016)

Of the seventeen highlighted indicators, one indicator TSQ2 was found to have a low factor loading of 0.040. Thus, it was excluded. The remaining sixteen indicators had factor loadings less than 0.70 and greater than 0.40. The impact of indicator deletion on AVE was analysed for all the sixteen indicators. It was found that seven out of sixteen failed to meet the minimum criteria and to have a significant impact on AVE and CR, thus they were eliminated. Table 6.50 shows the seven items that were deleted from the original model.

#	Items	Description
1.	TSQ2	Ease to learn
2.	TSQ5	System availability
3.	TSQ8	System reliability
4.	TSQ9	System fulfilment
5.	TSQ10	Security
6.	TSQ11	Personalization
7.	BNT3	Easier interaction and communication

Table 6.50: Items excluded from the model

Six excluded items belonged to the Technical System Quality construct, the other indicator belonged to Benefits constructs. The rest of indicators and relationships remained the same.

The algorithm in SmartPLS was recalculated and the model was re-estimated as shown in Figure 6.38. The outer loading for each indicator is shown on the arrow and inside the constructs the AVE values are reported.

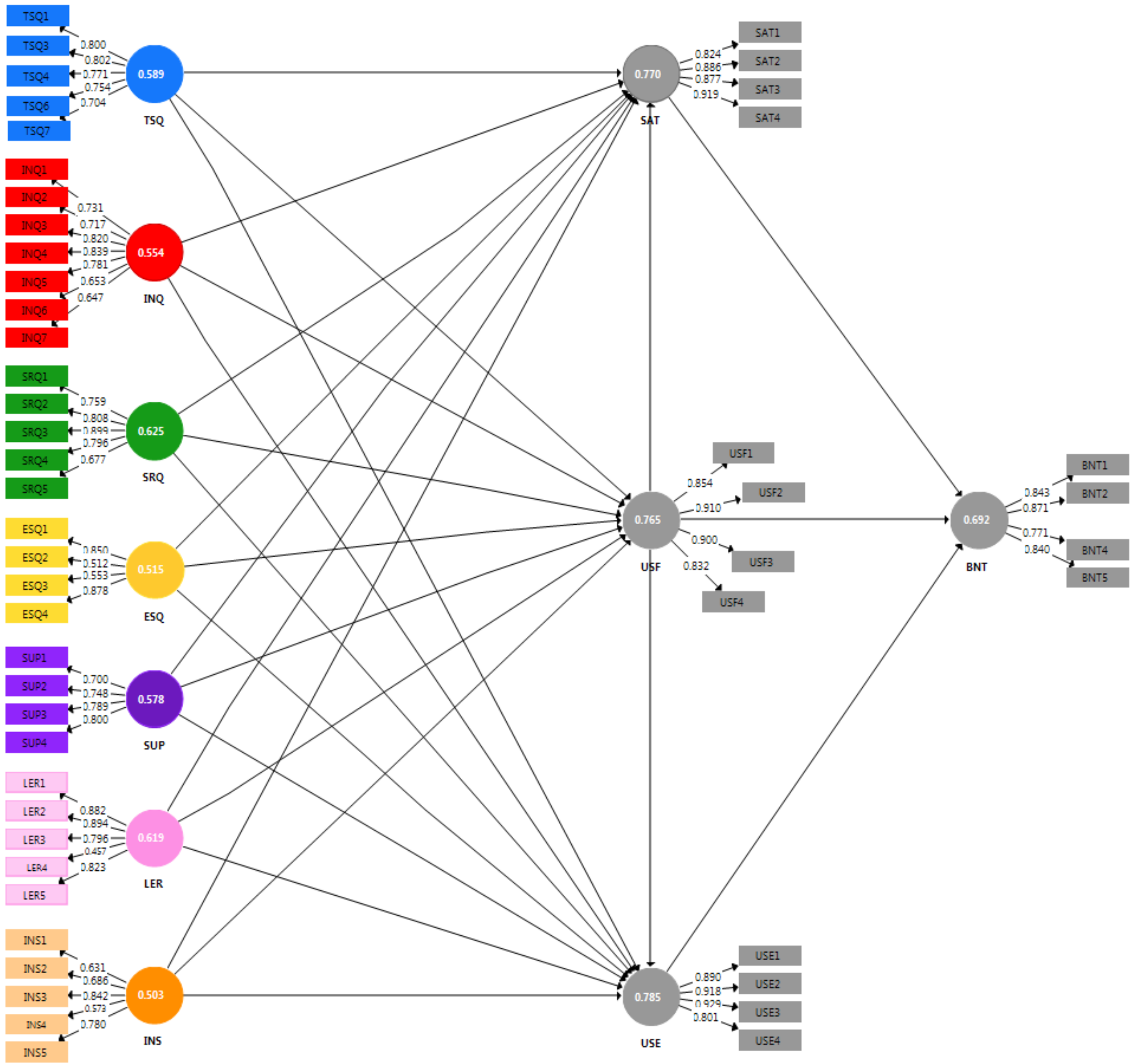


Figure 6.38: Refined version of the Measurement Model

Note: TSQ: technical system quality; INQ: information quality; SRQ: service quality; ESQ: educational system quality; SUP: support system quality; LER: learner quality; INS: instructor quality; SAT: perceived satisfaction; USF: perceived usefulness; USE: system use; BNT: benefits

Step2: Internal Consistency Reliability Results

The second criterion utilised for the assessment of the measurement model in PLS was the internal consistency reliability of the constructs. This was measured using two tests (Cronbach's Alpha α; Composite Reliability CR). The cut off value for both tests should be ≥ 0.70. The researcher ran these tests using SmartPLS version 3.0. Accordingly, the results are presented in Table 6.51 for each construct.

Constructs	Cronbach's Alpha α	Composite Reliability CR
TSQ	0.830	0.880
INQ	0.860	0.900
SRQ	0.850	0.890
ESQ	0.710	0.800
SUP	0.800	0.850
LER	0.840	0.890
INS	0.750	0.830
SAT	0.900	0.930
USF	0.900	0.930
USE	0.910	0.940
BNT	0.850	0.900

Table 6.51: Internal Consistency Reliability Test

As can be seen from Table 6.51 above, all values meet the minimum requirement for internal consistency reliability. The Cronbach’s alpha coefficients for the 11 variables are ≥ 0.70 with a minimum of 0.710 for the educational system quality construct and a maximum of 0.910 for system use. The composite reliability values also exceeded the cut off value of 0.70 for all constructs with minimum value of 0.800. The results of the reliability test indicate that the indicators used to measure each of the eleven variables are closely related as a group inside the one variable.

Step3: Construct Validity Results

The first subcategory of validity is convergent validity, which refers to the degree to which two measures of the construct that theoretically should be related are related. The AVE is used to assess the convergent validity. The rule of thumb is AVE ≥ 0.5. As can be shown in the path model in Figure 6.38 above, the AVE values are reported inside the circles (the constructs). All AVE values are greater than 0.50.

The discriminant validity is the other type that needs to be tested in the measurement model. Research emphasizes the need to assess discriminant validity, as it is critical to later conclusions regarding relationships between the constructs. As indicated in the methodology part of this chapter, three methods are employed to test discriminant validity.

The first one is the Fornell-Larcker method, which compares the square root of the AVEs ($\sqrt{\text{AVE}}$) on the diagonal between the construct itself and all other constructs. The correlation matrix is presented in Table 6.52:

	BNT	ESQ	INQ	INS	LER	SAT	SRQ	SUP	TSQ	USE	USF
BNT	**0.83**										
ESQ	0.35	**0.72**									
INQ	0.56	0.37	**0.74**								
INS	0.56	0.37	0.44	**0.71**							
LER	0.69	0.33	0.67	0.54	**0.79**						
SAT	0.73	0.33	0.68	0.52	0.58	**0.88**					
SRQ	0.32	0.14	0.43	0.29	0.35	0.41	**0.79**				
SUP	0.50	0.37	0.42	0.37	0.52	0.49	0.32	**0.76**			
TSQ	0.54	0.32	0.52	0.45	0.62	0.63	0.41	0.36	**0.77**		
USE	0.48	0.31	0.34	0.29	0.47	0.46	0.15	0.36	0.33	**0.89**	
USF	0.75	0.31	0.59	0.49	0.69	0.73	0.32	0.51	0.54	0.55	**0.87**

Table 6.52: The Fornell-Larcker Discriminant Validity Correlation Matrix

The AVE should more explain the same construct rather than the other constructs. In other words, the values on the diagonal should be higher in the same construct compared with other constructs. It is clearly shown that the diagonal values are larger than the other values inside the one column.

The cross loadings form the second method utilised to assess the discriminant validity. The cross loadings were retrieved to assess the loading of each indicator (see Appendix E). It can be clearly seen that each indicator loads highest on the construct it is associated with.

The new criterion HTMT introduced by Henseler et al. (2015) was the third method employed in this study for assessing discriminant validity. The HTMT values were retrieved using SmartPLS software (Table 6.53).

	BNT	ESQ	INQ	INS	LER	SAT	SRQ	SUP	TSQ	USE	USF
ESQ	0.38										
INQ	0.65	0.41									
INS	0.68	0.48	0.52								
LER	0.79	0.37	0.75	0.66							
SAT	0.83	0.36	0.77	0.61	0.81						
SRQ	0.37	0.18	0.51	0.35	0.41	0.47					
SUP	0.52	0.35	0.42	0.41	0.52	0.47	0.37				
TSQ	0.64	0.38	0.84	0.55	0.71	0.72	0.50	0.37			
USE	0.55	0.32	0.38	0.33	0.52	0.50	0.17	0.34	0.36		
USF	0.83	0.33	0.66	0.57	0.76	0.80	0.36	0.50	0.62	0.61	

Table 6.53: The HTMT Correlation Matrix

The threshold level of HTMT is 0.90 according to Gold et al. (2001) and Teo et al. (2008). By observing the values in Table 6.53 above, all HTMT values are within the accepted threshold values < 0.90. Based on examining the measurement model with the three discriminant validity tests, it can be concluded that all measures meet the discriminant validity criteria. Table 6.54 summarizes the results of the measurement model assessment.

Latent Variable	Indicators	Reliability			Validity	
		Indicator Reliability	**Internal Consistency Reliability**		**Convergent Validity**	**Discriminant Validity ***
		Factor Loadings	**Cronbach's Alpha**	**Composite Reliability CR**	**AVE**	**HTMT**
		Loading > 0.70 or > 0.40 & has no impact on AVE and CR	**α ≥ 0.70**	**CR ≥ 0.70**	**AVE ≥ 0.50**	**HTMT < 0.90**
TSQ	TSQ1	0.800	0.830	0.880	0.589	Yes
	TSQ3	0.802				
	TSQ4	0.771				
	TSQ6	0.754				
	TSQ7	0.704				
INQ	INQ1	0.731	0.860	0.900	0.554	Yes
	INQ2	0.717				
	INQ3	0.820				
	INQ4	0.839				
	INQ5	0.781				
	INQ6	0.653				
	INQ7	0.647				
SRQ	SRQ1	0.759	0.850	0.890	0.625	Yes
	SRQ2	0.808				
	SRQ3	0.899				
	SRQ4	0.796				
	SRQ5	0.677				
ESQ	ESQ1	0.850	0.710	0.800	0.515	Yes
	ESQ2	0.512				
	ESQ3	0.553				
	ESQ4	0.878				
SUP	SUP1	0.700	0.800	0.850	0.578	Yes
	SUP2	0.748				
	SUP3	0.789				
	SUP4	0.800				
LER	LER1	0.882	0.840	0.890	0.619	Yes
	LER2	0.894				
	LER3	0.796				
	LER4	0.457				
	LER5	0.823				
INS	INS1	0.631	0.750	0.830	0.503	Yes
	INS2	0.686				
	INS3	0.842				
	INS4	0.573				
	INS5	0.780				
SAT	SAT1	0.824	0.900	0.930	0.770	Yes
	SAT2	0.886				
	SAT3	0.877				
	SAT4	0.919				
USF	USF1	0.854	0.900	0.930	0.765	Yes
	USF2	0.910				
	USF3	0.900				
	USF4	0.832				
USE	USE1	0.890	0.910	0.940	0.785	Yes
	USE2	0.918				
	USE3	0.929				
	USE4	0.802				
BNT	BNT1	0.843	0.850	0.900	0.692	Yes
	BNT2	0.871				
	BNT3	0.771				
	BNT5	0.840				

Table 6.54: Results summary of the Measurement Model

*Results of Cross-loadings and Fornell-Larcker were reported in Appendix E and Table 6.52 respectively

6.3.2 Assessment of Structural Model Results

The assessment results of the structural model are presented in this section. The structural model has been assessed as suggested by Hair et al. (2016), using the following steps:

1. Assess structural model for collinearity issues (VIF< 5);
2. Assess the significance and relevance of the structural model relationships (p< 0.05);
3. Assess the level of R^2;
4. Assess the level of Q^2;
5. Assess the model's fit.

Step1: Assessment of the structural model for collinearity issues

Collinearity symptoms are assessed by generating the variance inflation factor VIF. A VIF value ≥ 5 indicates potential collinearity problem. Thus, the cut-off value used in this study for accepted collinearity level is VIF < 5 (Hair et al., 2016). The results obtained for VIF are shown in Table 6.55.

	SAT	USF	USE	BNT
TSQ	2.36	2.35	2.26	-
INQ	2.70	2.66	2.60	-
SRQ	1.31	1.31	1.33	-
ESQ	1.30	1.30	1.29	-
SUP	1.58	1.52	1.51	-
LER	2.73	2.41	2.74	-
INS	1.59	1.55	1.59	-
SAT	-	-	-	2.13
USF	2.43	-	2.19	2.42
USE	-	-	-	1.45

Table 6.55: SmartPLS results for VIF values

The retrieved VIF values are all within the accepted threshold values (VIF < 5). Thus, collinearity is not a problem in our data.

Step2: Assessment of the Significance and Relevance of the Structural Model Relationships

The path coefficients (β values) of the relationships between the constructs in the model are shown in Figure 6.39. The significance of the path coefficient is assessed using the algorithm of bootstrapping in PLS. 5000 bootstrap samples were generated. The *t* and *p* values are used to test whether the path coefficients β values are statistically significant at 5% error probability. The statistical significance level at 5% indicates that *p* value has to be < 0.05 to accept the hypothesis and *t* value > 1.65. Results of bootstrapping algorithm are shown in Table 6.56:

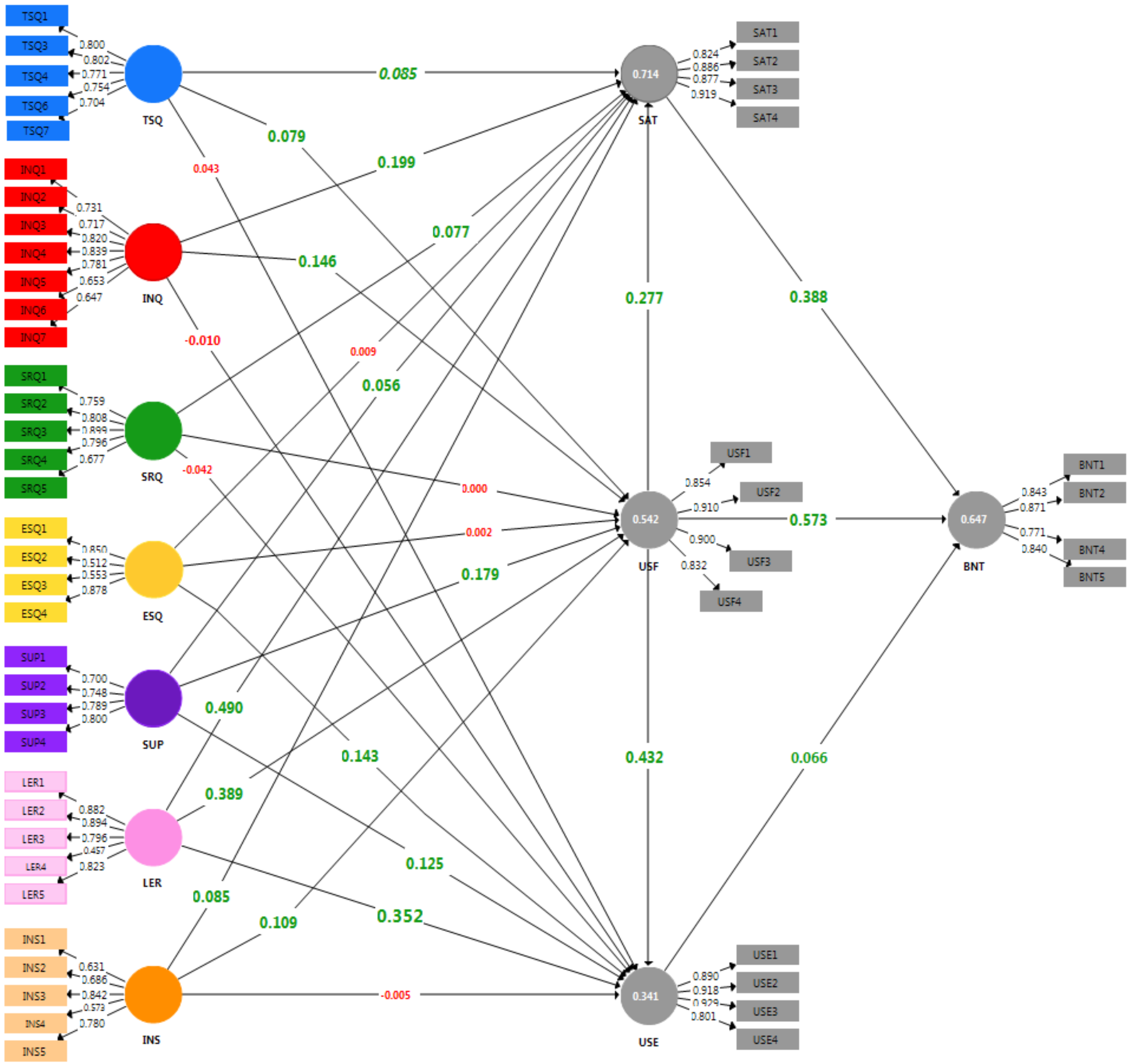


Figure 6.39: Structural Model Path Coefficients

Table 6.56 presents the results of testing the hypotheses proposed in chapter 3 (section 3.4). Based on the results of SmartPLS bootstrap samples (5000 generated samples), hypotheses can be supported or rejected. The statistical significance level is 5% (i.e., p value < 0.050 and t value > 1.65 to accept the hypothesis).

#	H	Path	β Coefficients	T Statistics	P Values	Sig.	Support
1.	**H1a**	**TSQ → SAT**	0.085	2.160	0.020	**	Accepted
2.	**H1b**	**TSQ → USF**	0.079	1.750	0.040	*	Accepted
3.	**H1c**	**TSQ → USE**	0.043	0.690	0.250	n.s	Rejected
4.	**H2a**	**INQ → SAT**	0.199	4.760	0.000	***	Accepted
5.	**H2b**	**INQ → USF**	0.146	3.050	0.000	***	Accepted
6.	**H2c**	**INQ → USE**	-0.010	0.160	0.440	n.s	Rejected
7.	**H3a**	**SRQ → SAT**	0.077	2.940	0.000	***	Accepted
8.	**H3b**	**SRQ → USF**	0.000	0.010	0.500	n.s	Rejected
9.	**H3c**	**SRQ → USE**	-0.042	1.050	0.150	n.s	Rejected
10.	**H4a**	**ESQ → SAT**	0.009	0.340	0.370	n.s	Rejected
11.	**H4b**	**ESQ → USF**	0.002	0.040	0.480	n.s	Rejected
12.	**H4c**	**ESQ → USE**	0.143	3.430	0.000	***	Accepted
13.	**H5a**	**SUP → SAT**	0.056	1.900	0.030	*	Accepted
14.	**H5b**	**SUP → USF**	0.179	5.330	0.000	***	Accepted
15.	**H5c**	**SUP → USE**	0.125	2.600	0.000	***	Accepted
16.	**H6a**	**LER → SAT**	0.490	11.860	0.000	***	Accepted
17.	**H6b**	**LER → USF**	0.389	7.440	0.000	***	Accepted
18.	**H6c**	**LER → USE**	0.352	5.130	0.000	***	Accepted
19.	**H7a**	**INS → SAT**	0.085	2.850	0.000	***	Accepted
20.	**H7b**	**INS → USF**	0.109	2.880	0.000	***	Accepted
21.	**H7c**	**INS → USE**	-0.005	0.100	0.460	n.s	Rejected
22.	**H8**	**SAT → BNT**	0.388	8.900	0.000	***	Accepted
23.	**H9a**	**USF → SAT**	0.277	6.650	0.000	***	Accepted
24.	**H9b**	**USF → USE**	0.432	8.040	0.000	***	Accepted
25.	**H9c**	**USF → BNT**	0.573	16.130	0.000	***	Accepted
26.	**H10**	**USE → BNT**	0.066	2.260	0.010	**	Accepted

Table 6.56: Results of Path Analysis and Hypotheses Testing

Note: TSQ: technical system quality; INQ: information quality; SRQ: service quality; ESQ: educational system quality; SUP: support system quality; LER: learner quality; INS: instructor quality; SAT: perceived satisfaction; USF: perceived usefulness; USE: system use; BNT: benefits
*: *P<.05,* **: *P<.025,* ***: *P*<.001, *n.s: not significant*

As can be seen in Table 6.56, 19 hypotheses out of the twenty six hypotheses formulated in the theoretical EESS model gained empirical support and were accepted. The strongest path coefficient was 0.573 between perceived usefulness and benefits (USF→ BNT). The other two paths connecting perceived usefulness with both USE and SAT were also significant with β values equal to 0.432 for USE and 0.277 for SAT.

The significance of the three paths connecting learner quality construct with perceived satisfaction, perceived usefulness and system use (i.e., LER → SAT, LER → USF, LER → USE) were all strong with β coefficient values of (0.490, 0.389, 0.352) respectively. The path between perceived satisfaction and benefits was also significant with β = 0.388.

The seven highlighted hypotheses were rejected, three of which were from the original model of DeLone and McLean (TSQ →USE, INQ → USE, SRQ → USE). Two paths connecting educational system quality with SAT and USF were rejected as the path coefficients β were weak and p values were less than 0.05. Finally, no support was found for the relationship between instructor quality and using the e-learning system (INS → USE). Table 6.57 summarizes the relationships found between the constructs.

Constructs	**Perceived Satisfaction**	**Perceived Usefulness**	**System Use**	**Benefits**
Technical System Quality	→	→		
Information Quality	→	→		
Service Quality	→			
Educational System Quality			→	
Support	→	→	→	
Learner Quality	→	→	→	
Instructors Quality	→	→		
Perceived Satisfaction				→
Perceived Usefulness	→		→	→
System Use				→

Table 6.57: Relationships found significant in the model

Step3: R^2 Level Assessment Results

The coefficient of determination R^2 has been used to measure the explained variance of the latent dependent variables relative to the total variance. The cut off levels in this study are: 0.190 weak; 0.333 moderate; and 0.670 substantial (Urbach and Ahlemann, 2010). Table 6.58 shows the R^2 values obtained for the latent variables in the model of the study.

Exogenous	**Endogenous**	**R^2**	**R^2 Power**
1. SAT → 2. USF → 3. USE →	**BNT**	**64.7%**	**Moderate to substantial**
1. TSQ → 2. INQ → 3. SRQ → 4. LER → 5. INS → 6. SUP → 7. USF →	**SAT**	**71.4%**	**Substantial**
1. TSQ → 2. INQ → 3. LER → 4. INS → 5. SUP →	**USF**	**54.2%**	**Moderate to substantial**
1. ESQ → 2. SUP → 3. LER → 4. USF →	**USE**	**34.1%**	**Moderate**

Table 6.58: Results of R^2 Level Assessment

A substantial percent of 71.4% of e-learning satisfaction was explained by seven constructs: technical system quality; information quality; service quality; learner quality; instructor quality; support system quality; and perceived usefulness. Five constructs were the main determinants of perceived usefulness, namely: technical system quality; information quality; learner quality; instructor quality; and support system quality. These five constructs together explained 54.2 % of the variance in perceived usefulness which is considered moderate to substantial. Four constructs were the main determinants of e-learning systems use, namely educational system quality, support system quality, learner quality and perceived usefulness. Collectively, these four constructs explained moderately 34.1 % of the system use construct, with perceived usefulness being the strongest determinant followed by learner quality, educational system quality and support system quality respectively.

Finally, perceived satisfaction, perceived usefulness and use explained 64.7% of the variance of e-learning benefits, which is considered moderate to substantial.

To summarize, the power of the coefficient of determination R^2 of the exogenous variables to explain the variance in the endogenous variables in the study model were substantial for perceived satisfaction, moderate to substantial for benefits and perceived usefulness, and moderate for system use which is a good indication of the effective selection of the model constructs.

Step4. Assessment of the Predictive Relevance Q^2 Results

Blindfolding in SmartPLS is used to obtain the predictive relevance Q^2, the omission distance D was 7. Table 6.59 illustrates the results.

Constructs	**Predictive Relevance Q^2**			
	Construct Crossvalidated Communality		**Construct Crossvalidated Redundancy**	
BNT	0.47	Strong predictive power	0.42	Strong predictive power
INQ	0.40	Strong predictive power	-	
INS	0.28	Moderate predictive power	-	
SAT	0.57	Strong predictive power	0.52	Strong predictive power
LER	0.44	Strong predictive power	-	
ESQ	0.26	Moderate predictive power	-	
USE	0.59	Strong predictive power	0.25	Moderate predictive power
SRQ	0.43	Strong predictive power	-	
SUP	0.30	Moderate predictive power	-	
TSQ	0.38	Strong predictive power	-	
USF	0.56	Strong predictive power	0.39	Strong predictive power

Table 6.59: Results of Q^2 Level Assessment

All values of Q^2 exceed the cut-off point (larger than zero). The cross-validated redundancy measures the capability of the path model to predict the endogenous constructs measuring items indirectly from the prediction of their own latent variables using the related structural relations. It is only computed for the endogenous variables. Table 6.59 shows that the model has strong predictive relevance for the endogenous constructs SAT, BNT and USF (the cut-off value for strong predictive is $Q^2 \geq 0.35$). Finally, USE has a moderate predictive power with $Q^2 = 0.250$.

In terms of the predictive relevance of the cross-validated communality, Q^2 values were calculated through the measurement model's capability to assess the path model directly from their own latent variable. The values of Q^2 in Table 6.59 above show 8 strong predictive powers and three moderate predictive powers. Results from both procedures suggest that the model has a good predictive power.

Step5. Assessment of the Model Fit

1. Standardised Root Mean Square Residual (SRMR)

SRMR is an absolute measure of model fit proposed to avoid model misspecification (Henseler et al., 2014). The cut-off-value used for SRMR is ≤ 0.08. Using SmartPLS software the SRMR for the current study is 0.070 which is less than the cut off value suggested in the literature.

2. Root Mean Square Residual (RMS theta)

This measure should be ≤ 0.12 to indicate a good model fit (Hair et al., 2016). Using SmartPLS RMS theta is 0.11 which indicates that the outer model residuals are small.

3. Goodness-of-Fit (GoF)

The model's Goodness-of-Fit for the current study is 0.49 as calculated in Table 6.60 which is deemed large.

Construct	**Crossvalidated Communality**	**R^2**
BNT	0.47	0.647
INQ	0.40	
INS	0.28	
SAT	0.57	0.714
LER	0.44	
ESQ	0.26	
USE	0.59	0.341
SRQ	0.43	
SUP	0.30	
TSQ	0.38	
USF	0.56	0.542
Average	**0.4255**	**0.561**
GoF= $\sqrt{\mathbf{R2} * \mathbf{average\ communality}}$ **= 0.4885 ≈ .49**		

Table 6.60: Results of GoF assessment

Table 6.61 presents a summary of the structural model assessment results.

	H	Path		β coefficients	P values	Support	R^2	R^2 power	Crossvalidated Communality Q^2	Predictive relevance	Crossvalidated Redundancy Q^2	Predictive relevance
1.	**H1a**	**TSQ**	→ **SAT**	0.085	0.020	Accepted			0.38	Strong		
2.	**H1b**		→ **USF**	0.079	0.040	Accepted						
3.	**H1c**		→ **USE**	0.043	0.250	Rejected						
4.	**H2a**	**INQ**	→ **SAT**	0.199	0.000	Accepted			0.40	Strong		
5.	**H2b**		→ **USF**	0.146	0.000	Accepted						
6.	**H2c**		→ **USE**	-0.010	0.440	Rejected						
7.	**H3a**	**SRQ**	→ **SAT**	0.077	0.000	Accepted			0.43	Strong		
8.	**H3b**		→ **USF**	0.000	0.500	Rejected						
9.	**H3c**		→ **USE**	-0.042	0.150	Rejected						
10.	**H4a**	**ESQ**	→ **SAT**	0.009	0.370	Rejected			0.26	Moderate		
11.	**H4b**		→ **USF**	0.002	0.480	Rejected						
12.	**H4c**		→ **USE**	0.143	0.000	Accepted						
13.	**H5a**	**SUP**	→ **SAT**	0.056	0.030	Accepted			0.30	Moderate		
14.	**H5b**		→ **USF**	0.179	0.000	Accepted						
15.	**H5c**		→ **USE**	0.125	0.000	Accepted						
16.	**H6a**	**LER**	→ **SAT**	0.490	0.000	Accepted			0.44	Strong		
17.	**H6b**		→ **USF**	0.389	0.000	Accepted						
18.	**H6c**		→ **USE**	0.352	0.000	Accepted						
19.	**H7a**	**INS**	→ **SAT**	0.085	0.000	Accepted			0.28	Moderate		
20.	**H7b**		→ **USF**	0.109	0.000	Accepted						
21.	**H7c**		→ **USE**	-0.005	0.460	Rejected						
22.	**H8**	**SAT**	→ **BNT**	0.388	0.000	Accepted	71.4%	Substantial	0.57	Strong	0.52	Strong
23.	**H9a**	**USF**	→ **SAT**	0.277	0.000	Accepted	54.2%	Moderate to Substantial	0.56	Strong	0.39	Strong
24.	**H9b**		→ **USE**	0.432	0.000	Accepted						
25.	**H9c**		→ **BNT**	0.573	0.000	Accepted						
26.	**H10**	**USE**	→ **BNT**	0.066	0.010	Accepted	34.1%	Moderate	0.59	Strong	0.25	Moderate
		BNT					64.7%	Moderate to Substantial	0.47	Strong	0.42	Strong

- Assessment of Model Fit: SRMR = 0.07 ≤ 0.08; RMS theta = 0.11 ≤ 0.12; GoF = 0.49 large goodness of fit)

Note: The cut-off value for strong predictive is $Q^2 \geq 0.35$; and moderate predictive power $Q^2 \geq 0.25$

The cut-off value to accept the hypothesis is $p < 0.05$

R^2 = 0.190 weak; 0.333 moderate; and 0.670 substantial

Table 6.61: Summary of the Structural Model Assessment Results

6.3.3 Content Analysis of Students' Comments Results

The questionnaire contained 58 items under 11 constructs. One optional open-ended question was added at the end of the questionnaire to allow respondents to add their comments about issues they face in the e-learning system. The methodology used to analyse the comments is content analysis, which helps to classify and categorize the issues affecting Moodle LMS from students' perspective. Of 563 responses only 103 students answered the question, with 258 comments. These comments were captured around the constructs of the model and revealed the problems students faced while using the system and suggestions to enhance and improve it. NVivo 11 was used to categorize and classify the themes derived. The themes, sub-themes elicited from the analysis of respondents' comments together with the frequency and percentages are presented in Table 6.62.

Themes	Subthemes	F	%*	Direction			
				Negative		Positive	
				F	%**	F	%**
Technical System Quality **81 comments out of 258 (31.4 %)**	Ease of Use	11	13.5	7	64	4	36
	Ease to Learn	2	2.4	2	100	-	-
	User Requirements	18	22.2	17	94.4	1	5.6
	System Features	36	44.4	27	100	-	-
	Flexibility	2	2.4	1	100	-	-
	Integration and Consistency	3	3.7	3	100	-	-
	Fulfilment	3	3.7	3	100	-	-
	System Reliability	4	4.9	2	50	2	50
	Personalization	2	2.4	1	50	1	50
Information Quality **65 comments out of 258 (25%)**	Sufficiency of Information	5	7.7	-	-	5	100
	Accessibility of Information	6	9.2	5	83.3	1	16.7
	Usability of Information	1	1.5	-	-	1	100
	Conciseness and Clarity of Information	10	15.3	9	90	1	10
	Understandability and Organization	20	30.7	20	100	-	-
	Up-to-date Content	7	10.7	5	71.4	2	28.6
	Content Design Quality	16	25	16	100	-	-
Service Quality **5 comments out of 258 (2%)**	Providing Guidance Services	4	75	4	100	-	-
	Providing Help	1	25	1	100	-	-
Educational System Quality **13 comments out of 258 (5 %)**	Interactivity and Communication	6	46.1	2	33.3	4	66.6
	Effective Communication	1	7.6%	1	100	-	-
	Diversity of Learning Styles	2	15.4	2	100	-	-
	Assessment Materials	4	30.7	-	-	1	100
Support System Quality **2 comments out of 258 (0.08 %)**	Ethical and Legal Issues	1	50	1	100	-	-
	Promotion of the E-learning System	1	50	1	100	-	-
Learner **10 comments out of 258 (4 %)**	Learner's Attitude	2	20	-	-	2	100
	Learner's Previous Experience	8	80	-	-	8	100
Instructor Quality **14 comments out of 258 (5.4 %)**	Instructor's Enthusiasm	2	14.2	-	-	2	100
	Instructor's Responsiveness	3	21.4	1	33.3	2	66.7
	Instructor's Interactive Communication	7	50	4	57	3	43
	Instructor's Attitude	2	14.2	-	-	2	100

Perceived Satisfaction **20 comments out of 258** **(7.8 %)**	Satisfaction with System Performance	6	30	2	33.3	4	66.7
	Enjoyable Experience	2	10	-	-	2	100
	Providing Educational Needs	1	5	-	-	1	100
	Overall Satisfaction	11	55	2	18.2	9	81.8
Perceived Usefulness **14 comments out of 258** **(5.4 %)**	Accomplishing Tasks	1	7.1	-	-	1	100
	Effective Learning	5	35.7	2	40	3	60
	Overall Usefulness	8	57.1	2	25	6	75
System Use **21 comments out of 258** **(8 %)**	Dependence on the System	10	47.6	2	20	8	80
	Regular Use	1	4.7	-	-	1	100
	Nature of Use	9	42.8				
	Frequency of Use	1	4.7	-	-	1	100
Benefits **13 comments out of 258** **(5 %)**	Achieving Learning Goals	1	7.7	-	-	1	100
	Improving Learning Process	5	38.4	-	-	5	100
	Time and Cost Saving	7	53.8	7	100	-	-

Table 6.62: Themes and sub-themes elicited from students' comments

***** The percentage was calculated based on the theme
** The percentage was calculated based on the sub-theme

6.3.3.1 Technical System Quality

This theme dominated students' comments, with 31.4% of responses received around the sub-themes. Thus, technical system quality is considered the most important theme based on the comments received. Nine sub-themes were identified under this theme, namely: Ease of Use, Ease to Learn, Flexibility, Fulfilment, Integration, User Requirements, System Features, System Reliability, and Personalization.

Ease of Use

The first sub-theme relates to ease of using the system. Ease of use is the degree to which students feel that using the e-learning system is free from efforts. 11 comments out of 81 comments were related to this sub-theme (13.5 % based on the theme). Of these comments, 64% of the students considered that Moodle was not easy to use, as evidenced by the following comments: '*It would be nice if we had a workshop on how to use Moodle in the beginning of the year as it is hard to get your head around*' (#258); '*Moodle is very hard to navigate… Blackboard is much simpler and effective E-learning system'* (#35); '*Difficult to navigate modules*' (#454); and '*The layout is a bit confusing and took time to get used to, as everything is in various places*' (#419).

Another student added '*It is ok but instructors need to know how to organise it to make it easier to use*' (#1). However, 36% of the students positively believe that Moodle is easy to use, for instance, '*It is fun and easy to use and I would recommend Moodle to everyone*' (#140); '*Quite easy to use*' (#421); '*I have used Moodle before, it is very easy to use*' (#334). Another student pointed to the ease of using Moodle compared to another online learning system MyWBS, '*Moodle is great, much easier to use than MyWBS*' (#216), where MyWBS is an online learning environment for students in the Warwick Business School.

Ease to Learn

The second sub-theme was ease to learn the system. Ease to learn is the degree to which students feel that the e-learning system is easy to comprehend and learn (DeLone and Mclean, 2003). This sub-theme received two comments, '*Hard to understand it at first*' (#484) and '*It could be made easier to read and understand*' (#5).

Flexibility

Flexibility of the e-learning system to interact with the interface received two comments '*Un-intuitive*' (#454) and '*Layout could be more intuitive such as the breakdown of modules by academic year even though some are still in use this academic year*' (#60).

Fulfilment

E-learning system fulfilment is related to system crashes and is defined as the probability that the e-learning system will offer the services free of bugs (Sedara et al., 2004). 3.7% of responses reported that they faced problems in dealing with Moodle. For example, '*Moodle unexpectedly crashes too often or you are unable to log in which makes me unable to rely on in it*' (#15); '*In this year, Moodle has crashed two times. It had influenced my study*' (#544) and '*It frequently crashes which can be very inconvenient as I rely on it so heavily for my studies*' (#71).

Integration and Consistency

E-learning system components' integration and consistency between different modules was identified as a sub-theme of e-learning technical system quality. This theme received 3.7% of the received comments. All the comments were in a negative direction. For instance, '*Key pieces of information are stored like grades should be consistent across different modules*' (#15); '*Format is not consistent*' (#317); '*Coursework and Exam Grades layout is inconsistent between modules and can be quite confusing*' (#5).

Meeting User Requirements and Finding the Needed Information

Meeting user requirements and finding the needed information were identified as key issues faced by students with 22% of the total comments received around the technical system quality theme. Approximately, 95% of the comments tended to be negative. Being hard to find the information is the most frequent problem faced by students. In this regard, students commented, '*Often within two modules information will be stored in completely different, illogical places and I spend too much time clicking around trying to find simple information*' (#15); and '*It is often very hard or impossible to find course information, e.g., information about module selection for next year*' (#170).

Students pointed that the difficulty of finding the information resulted in increasing the time to retrieve information and complete tasks, e.g., '*Finding the required files/information is sometimes very hard and time consuming due to the poor design and organisation of Moodle*' (#35); and '*Moodle provide the required information but it's really hard to find most of the time*' (#425).

The organization of content in the e-learning system disrupted students while using it, e.g., '*Difficult to access specific files as we don't know where they are, usually hidden in a specific folder*' (#426); '*I think the issue with Moodle is the difficulties in finding things*' (#429); '*Too many components sometimes finding specific info is hard as we have to remember where is located*' (#455); '*Difficult to find information in the Faculty of Medicine*' (#456); '*Sometimes we are asked to find a resource on Moodle and it can be very hard to find, some things for our second year modules are found in the year 1 tab, there are several tabs for each hospital, some with too much information in them, some with none*' (#51).

Also, students pointed out that the poor organization of information urged them to ask others, e.g., '*I have had experiences where I have to ask other students where our assignment is located, they generally agree that things can be hard to find*' (#251) and '*On module info pages there is far too much information. It is really hard to find information I need specific to each hospital trust and it is not where I expect to find it*' (#59).

One student expressed how hard it is to find information in Moodle in a funny way, she stated '*If I were Colonel Sanders and I needed to hide KFC's secret recipes I would put them on Moodle*' (#457).

The positive comment in this sub-theme was stated by response (#131) '*Moodle is not the most attractive software but it is definitely better than no e-learning platform, has most of the needed resources'*.

Personalization

Personalization revolves around providing an e-learning system that directly contributes to a student's learning (Ozkan and Koseler, 2009). Two comments pointed to personalization as a factor in e-learning systems success. '*It would be useful to have a personalised Moodle page to list only my modules, rather than scrolling through the department's list each time*' (#313) and '*More images and personalisation would be good*' (46).

System Features

The next sub-theme under technical system quality is that of system features. This sub-theme is related to the existence of the necessary features and functions needed by students in the e-learning system. This sub-theme received 44.4% of the comments and can be considered the most important factor under this construct according to students comment. Students' comments under the system features sub-theme were mainly around four key issues: lecture capture, mobile version, notification function, and search tool.

- Lecture Capture

The most frequent word was Lecture Capture under this sub-theme. Lecture Capture is a service offered via Moodle that produces video recordings of the lectures for their students to access. It gives students the chance to revisit lecture recordings and can store the lectures captured for up to four years. In this regard, students' comments were divided in two directions. The first direction was positive and appreciated this service, and the second one reveals problems faced with Lecture Capture. Examples of the first direction were: '*I see Moodle as a gateway. It links useful things like the module handbook and lecture capture*' (#277); '*Lecture capture is also a part of Moodle which is a useful feature as I am personally heavily dependent on lecture capture for my education*' (#304); '*I use Moodle to retrieve my reading lists and access lecture capture*' (#475); and '*I use Moodle frequently to access lecture capture*' (#528).

In relation to the second direction, students stated '*Lecture capture should be available more easily and quickly*' (#120); '*The lecture capture system is often broken*' (#209); '*Lecture captures of other modules in other departments as well should be accessible during the summer, to make the choice for optional modules easier and give us more time to decide*' (#88) and '*Lecture capture available on Moodle can be so slow to the point of not working at all*' (#97).

- Notifications

Notifications were a missing system feature highlighted by respondents. Students appreciated adding a notification feature to the e-learning system: '*Notifications and updates make Moodle more powerful*' (#389); '*Some way of giving forum notifications that are more noticeable would be good, e.g., notifications on the Moodle page itself*' (#246); '*It would be great to have a feature where a text/notification is sent to my mobile to tell me that a new grade is available to view on Moodle; as I don't always have access to or the time to log into my uni email and check if grades have been released*' (#5); and '*A notification system on what's been uploaded and updated is also appreciated*' (#99).

- Search

Another important missing system feature highly requested from students was having a search function. Regarding this issue, students commented that '*There is no Moodle search function which searches page content rather than just page headings*' (#170); '*Moodle* *needs a much better search function*’ (#417); ‘*Search tool is needed*’ (#418), ‘*A search feature would be useful*’; and ‘*Search facility needed*’ (#414).

- Mobile

Mobile features received attention from students with four comments. Students’ comments reveal problems students face when they open Moodle using their mobile phones. For example, ‘*Mobile version is poor*’ (#415); ‘*Have had issues logging in on mobile devices*’ (#238); and ‘*Better optimised for pc than mobile phones*’(#10).

- Other system features

Students pointed to adding ‘grades’ to the e-learning system. Students’ comments were between not having this feature at all and having it with some modules but not all of them, including, ‘*When the page which should display grades across all modules it shows all the modules but not all the grades, for both this and previous years*’ (#547); and ‘*It would be great to have an integrated calculator that shows your current results such as your average grade*’ (#498). Two students negatively expressed that there was no consistency regarding storing grades across the different modules: ‘*... Key pieces of information are stored like grades should be consistent across different modules*’ (#15); and ‘*Coursework and exam grades layout is inconsistent between modules and can be quite confusing*’ (#5). Students also appreciated sending a text message to mobile or email when grades have been released (#5).

Seven comments were also gathered around system features students find them useful for their e-learning system. These features were: adding a ‘frequently-accessed’ section, adding comments with relevant sections, uploading past papers with answers, providing 4 slides per page to save time and space, timetables, and providing all lectures in pdf format.

System Reliability

The last sub-theme in technical system quality is the reliability of the e-learning system. System reliability is defined as the probability that the e-learrning system will provide the learning tasks at the specified time (DeLone and McLean, 2003). This sub-theme collected 4 comments with approximately 5% of the comments received under this theme. These comments were evenly divided: 50% positive and 50% negative. For instance, ‘*Sometimes when going back an error appears but is easily closed without any apparent issue*’ (#287) and ‘*Great system, no problems so far*’ (#114).

6.3.3.2 Information Quality

Analysis of received comments confirmed that information quality is considered one of the key constructs influencing the success of the e-learning system. Information quality is concerned with the desired characteristics required by the user in relation to the content and information in the e-learning system such as clarity, up to date, and sufficiency of information. This theme received 65 comments with 25% from the total comments collected. Of these comments, understandability of information and organization into logical well-organized components came first, followed by the content design quality, conciseness and clarity of information, and up to date content. These sub-themes received the majority of students' comments.

Understandability and Organization of Information

Understandability is organizing the information into logical and understandable components in the e-learning system. This sub-theme collected 20 comments with 30.7%. All the comments about understandability were negative. Reviewing students' comments shows that there are issues related to the structure of content and organization of information in Moodle. In this regard, students stated for example that '*Sometimes I don't understand the categories within a certain module*' (#126); and '*Moodle is useful for modules that are well organised, however it is more difficult to use when other modules do not organise their content in a structured way as it is difficult to find the correct content*' (#18). Another student added, '*The organisation of learning materials is not always good' (#51).*

Some students pointed that the poor organization of content and the difficulty in finding information were not related to the system '*I think the issue with Moodle is the difficulties in finding things; has more to do with the lecturers putting thing in the wrong place rather than a problem with Moodle*' (#429); '*Moodle is sufficiently usable but not as organised as other systems I've used*' (#432); *'Good tool but somewhat poor structure*' (#57); '*Some things for our second year modules are found in the year 1 tab*' (#51); and '*Could be organised much better*' (#46).

Content Design Quality

The second sub-theme based on the comments' frequency was the content design quality. This received 16 comments, with 25% within the information quality theme. Content design quality is related to providing pleasant design of the e-learning system that meets quality standards to users (Roca et al., 2006). Students noted the software as 'unappealing', 'unattractive', 'unintuitive' with 'inefficient' and 'complicated layout'; they further commented on the font and design being old, and on the difficulty on finding information. Students' feelings about this sub-theme were all negative. Students agreed that the design was not pleasing. Regarding this, students stated '*The site graphic is unappealing*' (#232); '*Not the most attractive software*' (#131); '*Poor design*' (#35); '*It could look more appealing*' (#109); '*Poor layout*' (#456); '*The font and design is old, the site as a whole* *could be updated from satisfactory to excellent*' (#505); '*Improve the design and layout of Moodle*' (#543); '*Layout could be more intuitive*' (#60); '*I find the layout of modules very inefficient*' (#427); '*Layout for medicine is complicated*' (#455); and '*Poor layout, difficult to find information in the Faculty of Medicine*' (#456).

Conciseness and Clarity of Information

This sub-theme is related to the students' feeling towards the information clarity in the e-learning system. It received 10 comments (15.3%), of these comments, one comment only was positive that is: '*It is clearer this year*' (#124). In regard to the negative feelings of students toward conciseness of information, for example, students stated that, '*Some resources are difficult to find - not clear which folder they are in*' (#436); and '*On module info pages there is far too much information*' (#59); and '*Too many components;* (#255).

Up to Date Content

There is no doubt that providing recent and updating the content is vital to the success of the e-learning system. Eight comments were gathered confirming that information, module contents, and announcements should be updated regularly. 71.4% of the comments were negative and 28.6% were positive. The negative feelings resulted from outdated content. Examples of negative comments include: '*Moodle really needs significant update to improve quality of the resource overall*' (#16); '*It is a bit of an outdated waste of money'* (#39)*; 'Presentations rarely uploaded on time*' (#426); '*Some of the Moodle information or study materials may not up to date*' (#545). On the other hand, positive feelings comments stated that '*How effective it is depends on how well academics use and update it*' (#389); and '*Does depend on whether administration upload the relevant lectures on time*' (#47).

Accessibility of Information

This sub-theme is related to the accessibility of information and resources needed from the e-learning system. In this regard, six comments were received, some being suggestions as to what students believe is useful for their study, for instance accessibility of content and information on reading devices:, '*It would be useful to provide all lectures in PDF format to allow access to reading devices such as Kindle*' (#17). The other comments were negative '*You need somewhere for course materials to be made accessible online, I'm not convinced Moodle does it very well*' (#425); '*Information not stored in an easy access way; e.g., lecture handouts only available from timetable chronological rather than by topic - very irritating during revision periods*' (#434); '*Should be able to access all that are in use this year in one place*' (#60); and '*Lecture captures of other modules in other departments as well should be accessible during the summer, to make the choice for optional modules easier and give us more time to decide*' (#88).

Sufficiency of Information

This is related to providing the sufficient and required information in the e-learning system. This sub-theme received 7.7% of the comments. From students' comments, all students agree that Moodle does provide the required information; however, it is hard to find them due to poor organization. For example, '*Moodle provide the required information but it's really hard to find most of the time*' (#425); '*Resources on Moodle can be very hard to find*' (#51); and '*It is really hard to find the information I need*' (#59).

Usability of Information

This sub-theme revolves around providing information in the e-learning system in an appropriate format that is readily usable by users. Only one comment received concerned the usability of Information offered in the e-learning system. A student stated, '*Information on Moodle is sufficiently usable but not as organised as other systems I've used*' (#432).

6.3.3.3 Service Quality

Service quality is concerned with the overall support delivered by IT services personnel to the students. The theme of service quality received five comments in total. These comments were about providing guidance services on how to use the e-learning system. For example, '*Would be nice if we had a workshop on how to use Moodle in the beginning of the year*' (#258); '*needs to be clearer and have more direction*' (#499); and '*Would be useful to get more instructions on how to use it*' (#124).

6.3.3.4 Educational System Quality

This theme gained students' attention and appreciation. It is related to the existence of interactivity and communication features, diversity of learning styles and assessment materials (e.g., quizzes, assignments) in the e-learning system which facilitate and improve conductive learning. Thirteen students commented regarding educational issues in Moodle, 5% of the total responses received. Students' comments can be grouped into four sub-themes, interactivity and communication features, 6 comments (46.1%); effective communication, 1 comment (7.6%); diversity of learning styles, 2 comments (15.4%); existence of assessment materials 4 comments (30.7%).

From the comments received, four were negative, e.g., '*New forum never used*' (#454); '*Lecturers don't use forum - don't reply*' (#204); and '*Need video lecture capture, better forum on Moodle and better tutor chat forums*' (442).

Other students suggested using different learning styles: '*More images … would be good*' (#46).

The comment received regarding effective communication was: '*Communication via Moodle has not been effective: I have sent messages via Moodle that haven't been responded to*' (#436).

Approximately, 69% of students commented positively regarding this theme. For example, '*I definitely like the paperless assignment submission system in Moodle - during my undergraduate study where we were required to submit both an electronic copy and a 'hard' copy - this was sometimes logistically quite difficult due to campus location and also not very 'green' environmentally speaking*' (#101); and '*I do enjoy when submitting work online in Moodle*' (#15).

Students appreciated having communication features in the e-learning system, for example, '*I think it is useful if they could more use Moodle communicative functions*' (#377); '*Perhaps they could include a communication features with the lecturer directly where ever you need assistance*' (#386); and '*Hopefully, it can be a bit more interactive in the future*'(#509).

6.3.3.5 Support System Quality

This theme received the fewest comments from students. It is related to the e-learning system supporting ethical and legal issues and the promotion of the e-learning system. Two comments only were received. These were: '*The forum is not anonymous and I am too intimidated / embarrassed to post anything on it*' (#195)'; and another student pointed that using Moodle was not the main focus as they have their own web page in the department: '*Some modules in my department do not use it (need it) we have our own web page / system*' (#353).

6.3.3.6 Learner Quality

This theme is related to learner characteristics such as attitude, previous experience, and skills that influence the success of the e-learning system. 10 comments were received in relation to this theme (4%). 90% of the comments received were in a positive direction and confirmed the positive attitude that students had towards e-learning systems. For example, '*E-learning systems are essential in education today; a place to access files electronically is necessary in successfully passing a course*' (#35); '*I definitely like the paperless assignment submission system in Moodle*' (#101); '*Moodle is not the most attractive software but it is definitely better than no e-learning platform, has most of the needed resources*' (#131); '*Moodle is amazing and has shaped my learning*' (#35); and '*I have used Moodle before, it is very easy to use*' (#334).

6.3.3.7 Instructor Quality

Content analysis of students' comments shows that the instructor is a key factor in the success of the e-learning system. This theme is concerned with the characteristics of the instructor in different aspects such as, enthusiasm interactive communication, attitude which are important for effective utilization of the e-learning system. 14 students pointed to the important role an instructor plays in an effective successful e-learning system (5.4% of the comments received). Students valued instructors' prompt responses and communication in the e-learning system. In this regard, students commented '*More timely responses to forum questions would be helpful*' (#246); '*Perhaps they could include a communication features with the lecturer directly where ever you need assistance*' (#386); and '*Need better tutor chat forums on Moodle*' (#442).

One comment received around instructor's communication: '*Communication via Moodle has not been effective, I have sent messages via Moodle that haven't been responded to*' (#436).

Based on the comments received, students noted that instructors needed to have the skills required to use the e-learning system efficiently. Students claimed that instructors do not use all the functions and tools available in Moodle, and they need to be aware of the features provided and how to organize the materials uploaded in the system. For example, '*Has more to do with the lecturers putting thing in the wrong place rather than a problem with Moodle*' (#429); '*It is ok but instructors need to know how to organise it to make it easier to use*' (#450); '*Does depend on whether administration upload the relevant lectures on time however*' (#47); '*Moodle is efficient as the people uploading content to it, so its efficiency varies widely*'; (#425).

Another student stated that Moodle is a blank canvas and its efficiency depends on academics: '*Moodle is like many other education facilitating sites, how effective it is at supporting learning depends on how well academics use and update it, i.e., it is a blank canvas*' (#421).

Clearly, comments received regarding this theme show that students agree that some issues with Moodle are due to a shortfall in the ability of instructors to utilise and manage Moodle effectively, and limited interaction. Additionally, the materials uploaded online are very much dependent on the how they are presented and organized by the instructor and how communication occurs between learners and the instructor.

6.3.3.8 Perceived Satisfaction

This theme is concerned with the students' level of satisfaction when utilizing the e-learning system. Analysis of students' responses shows that satisfaction is a key construct in the evaluation of e-learning systems success with 20 comments (that is 10% of the total comments received). From these comments, 80% were positive comments indicating satisfaction with the e-learning system, in general, and having an enjoyable experience. For example, '*Moodle is amazing and has shaped my learning at Warwick. It is fun and easy to use and I would recommend Moodle to everyone*' (#140); '*I do enjoy how when submitting work online in Moodle it tells you how much time you have left*' (#15); '*I am fairly satisfied with how it works' (#385); 'I am satisfied with it*'; '*Moodle is great, much easier to use than "MyWBS*"' (#216); '*I am satisfied with it perhaps they could include a communication features with the lecturer directly where ever you need assistance*' (#386); '*Great system, no problems so far. Much better than "MyWBS"*' (#114); and '*Could be updated from satisfactory to excellent*' (#505). Regarding the negative feelings, for example, one student commented: '*Moodle doesn't get in my way which is what you want from an e-learning system I guess*' (#171).

6.3.3.9 Perceived Usefulness

Perceived usefulness is a perceptual measure of the degree to which users believe that using the e-learning system would enhance their learning performance (Davis, 1989). The main sub-themes that students pointed to around this theme were the overall usefulness of the e-learning system and effective learning with 14 comments received (5.4%). From the received opinions, 77% confirmed that the e-learning system was useful for their study. For example, '*By far, one of the most efficient and useful e-learning systems that I have come across*' (#147); '*Generally it is effective tool to help to manage my academic study*' (#545); '*Moodle is efficient as the people uploading content to it so its efficiency varies widely*' (#425); '*Moodle is useful for modules that are well organised*' (#18); '*I found it useful*' (#484). With regard to students' negative feeling, for example, a student stated '*I didn't find Moodle that useful, I don't mind it as a study tool, however, it is not an addition to my study*' (#303).

6.3.3.10 System Use

The overall actual usage of the e-learning system is a factor in the success of the system. The usage of Moodle received 21 comments (8%). 10 of them were around the sub-theme dependence on the system, 9 were related to the nature of using the system, 1 about regular use of the system and 1 comment received about the frequency of using the system. 31% of the comments were positive. For example, '*I use Moodle frequently to access lecture capture*' (528); '*Cannot study without Moodle*; (#354); '*Lecture capture is also a part of Moodle which is a useful feature as I am personally heavily dependent on lecture capture* *for my education*' (#304); '*Mainly used to download the PPT, and do some exams in class*' (#127); and '*I mainly use it to check my timetable and any necessary resources*' (#124).

Examples of negative comments: *'My use for Moodle is limited*' (#377); '*I don't see its individual use aside from assignment submissions*' (#277); '*It's not something I use regularly, just to retrieve my reading lists and access lecture capture*' (#475); '*Moodle unexpectedly crashes too often or you are unable to log in, which makes me unable to rely on in it*' (#15); '*It frequently crashes which can be very inconvenient as I rely on it so heavily for my studies*' (#71); and '*Required to use Moodle out of necessity as it's the only place to access the resources lecturers upload*' (#518).

6.3.3.11 Benefits

This theme is about the benefits obtained from using the e-learning system on students. It is the output construct on our study model and is concerned with student's perceptions of the expected general benefits (i.e. overall individual impacts) resulted from using the e-learning system such as, increasing knowledge, improving learning process, time and cost saving, and achieving learning goals. 13 comments were elicited (5%). These comments were around three issues: achieving learning goals; improved learning process; time and cost saving. In relation to achieving learning goals, one student stated, '*By far, one of the most efficient and useful e-learning systems that I have come across. Helps achieve almost all the learning goals set in the course*' (#147).

Regarding improving the learning process, for example, students stated '*Moodle aids me with my learning as well as understanding with individual modules*' (#297); and '*Moodle seems to make it quite easy to use allowing staff to update information on it more effectively; facilitating student learning*' (#421); and '*Generally it is effective tool to help to manage my academic study*' (#545).

Comments around these two sub-themes (i.e., achieving learning goals and improving the learning process) were positive. However, 85% of the comments received in relation to the time and cost saving sub-theme, students negatively believed that Moodle helped them in saving time and cost. For example, '*I spend too much time clicking around trying to find simple information*' (#15); and '*Finding the required files/information is sometimes very hard and time consuming due to the poor design and organisation of Moodle*' (#35).

A visualisation for the most frequent words students mentioned in their comments was retrieved using NVivo 11 as can be seen in Figure 6.40.

Figure 6.40: Word Frequency Count Based on Students' Comments

6.4 Chapter Summary

This chapter set out to test the study model and hypotheses. 58 indicators were selected in the study model for the evaluation of e-learning systems success under 11 constructs: technical system quality, information quality, service quality, educational system quality, learner quality, instructor quality, support system quality, perceived usefulness, perceived satisfaction, system use, and benefits. The first section was the methodology used for testing the measurement model, the structural model and content analysis of students' comments. PLS was utilized to test the measurement model and hypotheses. Measurement model assessment was conducted using: internal consistency reliability and construct validity. Results of the measurement model excluded 7 factors from the model and kept the remaining 51 indicators. Overall, the measurement model assessment results confirmed the reliability and validity of the selected factors and constructs and the whole model to evaluate e-learning systems success.

For the structural model, assessment was performed following the five steps: assessment of collinearity issues, assessment of relationships significance between the constructs, assessment of R^2 level, predictive relevance Q^2, and assessment of the whole model fit.

Path analysis in the structural model showed that 19 hypotheses out of 26 have gained empirical support, thus were accepted. Results of structural model assessment also showed that the amount of variance explained in this model was substantial for perceived satisfaction (71.4% of e-learning satisfaction was explained), and moderate to substantial for benefits of e-learning (64.7% was explained) and perceived usefulness (54.2%), and moderate for system use (34.1%). Further, the model has strong and moderate predictive relevance Q^2 and large goodness-of-fit value.

The last part in this chapter presented the content analysis of the students' comments. Results show that the factors influencing the success of e-learning system based on their relevance to students were technical system quality; information quality; satisfaction; educational system quality; use; usefulness; instructor quality; benefits; learner quality; service quality; and support quality respectively.

CHAPTER SEVEN: DISCUSSION OF RESULTS

7.1 Chapter Introduction

This study proposed a model for the evaluation of e-learning systems success. Structural equation modelling, and more specifically, the composite-based approach PLS-SEM using SmartPLS 3, was adopted to analyse the data collected from students using Moodle LMS. PLS-SEM consists of two models, the measurement and structural model. The measurement model is the outer model, which consists of the factors (constructs) and the indicators (observed variables) used to measure their construct, whereas, the structural model represents the research hypotheses and the relationship between the constructs of the model. Results of model testing were reported in chapter 6. More details about model testing results, and the performance of the model, are now provided in this chapter. The present chapter is organised into 6 sections. Introduction comes in the first section. The second section presents a discussion of the results of measurement model. The third section is a discussion of the results of structural model and testing the hypotheses. The fourth section discusses the content analysis results. The fifth section discusses the performance of the model and a comparison of the performance of the model with the performance of models developed by prior studies. Finally, a summary is given in the last section.

7.2 Discussion of Measurement Model Results

The study model emphasized the value of evaluating the success of e-learning in all phases, starting from the design phase operationalized by quality and social factors which are the antecedents of the delivery phase that consists of system usage, and user beliefs about the usefulness and satisfaction of the system, which, in turn, influence the outcome phase, i.e., the benefits achieved from using the e-learning system. Figure 7.41 illustrated the three phases.

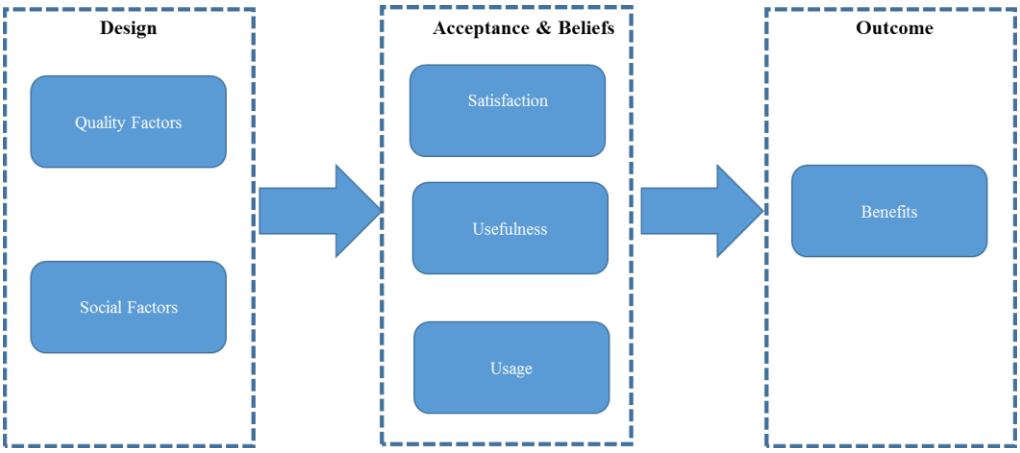


Figure 7.41: The Simplified Conceptual Model for Evaluating the Success of E-Learning System

This study adopted seven independent constructs as the foundation for the success of e-learning to represent quality and social factors. Quality was evaluated using four constructs: technical system quality, information quality, service quality, and educational system quality. Three constructs were used to represent social factors: instructor quality, learner quality, and support system quality. These seven constructs were proposed to be the direct antecedents of perceived satisfaction, perceived usefulness and use of the system. Success in the two phases results in success of the outcome evaluated by the benefits achieved. The following is a discussion of measurement model assessment results for the 11 constructs of the model.

1 Technical System Quality

For the technical system quality construct, initially, 11 indicators were utilized to measure this. Each indicator was adopted to measure a specific aspect of system quality: ease of use; ease to learn; meeting user requirements; system features; system availability; flexibility; integration and consistency; system reliability; fulfilment; security; and personalization. However, six indicators were eliminated from this construct: ease to learn; system availability; system reliability; fulfilment; security; and personalization. Elimination of these six indicators was based on statistical grounds, as they failed to meet the criteria discussed earlier in section 6.3.1, and they were found to be insignificant to represent this construct. Elimination of these factors from the construct assisted in improving the construct reliability and validity.

The remaining indicators confirmed the reliability and validity of the technical system quality construct in the success of e-learning systems. This finding is in agreement with prior studies which showed that technical system quality is a valid and reliable construct, for example, Roca et al., 2006; Selim, 2007; Hassanzadeh et al., 2012; Al-Sabawy, 2013; and Cidral et al., 2018.

2 Information Quality

Regarding the information quality construct, seven indicators were employed to gauge this construct: sufficiency of information; accessibility; usability; conciseness and clarity; understandability; up to date content; content design quality. The results of the measurement model assessment showed the reliability and validity of the indicators and the construct in the e-learning systems success. This result is in line with prior studies conducted by Holsapple and LeePost, 2006; Roca et al., 2006; and Ozkan and Koseler, 2009.

3 Service Quality

Service quality is related to the services provided by IT staff. In the study conducted by Ozkan and Koseler (2009) it was found that the services provided by the administrative staff highly influence learners' satisfaction level. Thus, it is important to have technical staff who have good control over the technology and who can perform troubleshooting tasks and follow up students' problems. Five items were employed to represent this construct: providing guidance services; providing online help; availability; fair understanding; and responsiveness. All five items significantly represented the construct. Results were in agreement with studies which employed service delivery quality as a valid and reliable construct (Roca et al., 2006; Lin, 2007; Ozkan and Koseler, 2009; Hassanzadeh et al., 2012; Al-Sabawy, 2013).

4 Educational System Quality

The opinions of the surveyed students regarding the educational quality of the e-learning system were measured using four indicators across the sub-dimensions: existence of interactivity and communication facilities such as chat, forum and others in the system; effective communication with instructor and other students; diversity of learning styles; the existence of evaluation and assessment components. The four items significantly represented the educational system quality construct, and thus, no item was removed. This finding confirms the important role that this construct plays, as shown by previous researchers (Chang and Chen, 2009; Lee, 2010; Vernadakis et al., 2011; Hassanzadeh et al., 2012).

5 Instructor Quality

The study assumed that instructor quality is an important construct for the success of an e-learning system. Five aspects were used to represent this construct. Those aspects were: subjective norm; instructor's enthusiasm; instructor's responsiveness to students; instructor's interactive communication; and instructor's attitude toward utilizing e-learning. The results from the measurement model assessment showed that all these items are significant and represented the construct, and thus, no item was deleted. The construct and indicators were valid and reliable and supported previous studies (Selim, 2007; Ozkan and Koseler, 2009; Cheng, 2011; Bhuasiri et al., 2012).

6 Learner Quality

There is no doubt that learners are the main stakeholders in any e-learning environment. Thus, understanding the characteristics and attitudes of learners toward the e-learning system is vital to the success of the e-learning system. Five items were employed to gauge learner's characteristics around the sub-dimensions: learner's behaviour; learner's attitude toward using e-learning; learner's anxiety; learner's previous experience; learner's self-efficacy. All the five items were remained and significantly represented the construct. As a result, learner quality is a key construct in the e-learning systems success. This result overlaps with the results in the literature (Webster and Hackley, 1997; Selim, 2007; Ozkan and Koseler, 2009; Bhuasiri et al., 2012), all of whom employed this construct in the evaluation of e-learning systems success, and found it to be a valid and reliable construct.

7 Support System Quality

This construct includes supportive factors that have an influence on students using the e-learning system. It covers ethical and legal issues, together with behavioural considerations and communication guidelines. The supportive issues, additionally, emphasized the importance of increasing the popularity and promotion of the e-learning system. Four indicators represented this construct under the following sub-dimensions: ethics, behavioural considerations, legal issues, and promotion of the e-learning. This is in parallel with the literature, where support was employed as a valid and reliable construct in the evaluation of e-learning systems success (Khan, 2005; Selim, 2007; Ozkan and Koseler, 2009).

In the developed model, the aforementioned seven constructs were operationalized to provide the input for the three central constructs: perceived satisfaction, perceived usefulness and system use. The following is a discussion of the results of the measurement model for these constructs.

8 Perceived Satisfaction

Satisfaction towards the e-learning system is a key construct in the success of the system. Satisfaction with system performance, enjoyable experience, providing the educational needs, and overall satisfaction with the system were the four items used to represent this construct. The results confirm the validity and reliability of the indicators and the construct in evaluating the success of e-learning. These results are supported by literature (Sun et al., 2008; Ozkan and Koseler, 2009; Hassanzadeh et al., 2012; Lin and Chen, 2012; Mohammadi, 2015).

9 Perceived Usefulness

Usefulness of the system is evaluated via the degree to which students believe that using the e-learning system would enhance their learning performance. The scale employed to assess this construct contained four indicators: accomplishing learning tasks; improving learning performance; effective learning; and overall usefulness. The indicators represented the construct and requirements of reliability and validity were met.

The findings support several studies that employed perceived usefulness as a separate construct to evaluate the success of e-learning systems. For example, in the study conducted by Sela and Sivan (2009), nine success factors were grouped under the two categories: 'must-have' and 'nice-to-have' factors. Usefulness was the first factor under the must-have factors. This finding is also consistent with Mohammadi (2015) and supports other researchers who employed this construct to evaluate the success of e-learning (e.g., Roca et al., 2006; Wang and Wang, 2009; Islam 2012; Al-Sabawy, 2013).

10 System Use

This construct represents the actual usage of the system. Four items were adopted to represent this construct: frequency of use; dependence on the system; regular use; and duration of use. The validity and reliability of use as a key construct for the evaluation of e-learning success were confirmed in this study and by e-learning researchers (e.g., McGill and Klobas, 2009; Hassanzadeh et al. 2012; Mohammadi, 2015; Cidral et al. 2018).

11 Benefits

In this study, the benefit achieved represents the outcome stage in the model, which directly results from the three constructs: perceived satisfaction, system use, and perceived usefulness. This construct captured five aspects of e-learning success in relation to increasing knowledge, improving learning process, easier interaction and communication, time and cost saving, and achieving learning goals. One indicator had a low factor loading and affected the reliability and validity of this construct, i.e., easier interaction and communication. Thus, it was deleted. The other four indicators significantly represented the construct and showed the validity and reliability of this construct to evaluate the success of e-learning system. This construct was successfully employed by other researchers (Holsapple and LeePost, 2006; Almarashdeh et al., 2010; Hassanzadeh et al., 2012; Cidral et al. 2018).

In summary, the measurement model assessment results confirmed the reliability and validity of the selected indicators and constructs to evaluate the success of e-learning systems.

7.3 Discussion of Structural Model Results and Hypotheses

The structural model, or the inner model, represents the relationships between the constructs. 26 relationships between 11 constructs were hypothesized in chapter 3. The model of the study was examined using data collected from students using Moodle LMS. The discussion of results is based on the findings presented in chapter 6.

7.3.1 Technical System Quality Hypotheses

Three hypotheses were proposed to investigate the relationships between the technical quality of the e-learning system and perceived satisfaction, perceived usefulness and use of the system:

H1a: Technical System Quality → Perceived Satisfaction ☑

H1b: Technical System Quality → Perceived Usefulness ☑

H1c: Technical System Quality → System Use ☒

The first two hypotheses gained empirical support, while the third was rejected. The results of examining the three hypotheses are discussed now in details.

H1a: Technical system quality positively influences the perceived satisfaction with the e-learning system.

The results of testing the relationship between technical system quality and perceived satisfaction supported hypothesis H1a. Thus, aspects related to the technical quality of the system such as ease of using the e-learning system, capability of the system to meet users' requirements, flexibility of the system to interact with, integration and consistency between the different components of the system, and the existence of features and function the users need are all important aspects, and contribute to the overall satisfaction with the e-learning system. For example, the existence of necessary features and functions in the e-learning system make users satisfied with the system performance. In addition, if the e-learning system meets students' requirements this will help students to achieve their educational needs. Similarly, consistent and integrated components enhance students' overall satisfaction with the system.

The significant impact of technical system quality on users' satisfaction was supported by studies conducted in the e-learning field (Ozkan and Koseler, 2009; Almarashdeh et al., 2010; Islam, 2011; Al-Sabawy, 2013; Cidral et al., 2018). The same findings have gained support through empirical studies in organizational study of e-learning (Wang et al. 2007; Samarasinghe, 2012) and other disciplines, for example, mobile-banking (Abbas et al., 2018), and in the e-government context (Wang and Liao, 2008).

H1b: Technical system quality positively influences the perceived usefulness of the e-learning system.

Hypothesis H1b focuses on the effect of the technical system quality of the e-learning system on students' perceived usefulness. Indicators used to represent perceived usefulness are related to students' beliefs about the usefulness of the e-learning system in enhancing their learning performance, learning effectively, and accomplishing learning tasks quickly. This relationship was found to be significant and gained empirical support. As a result, students' perceptions towards the usefulness of the system can be achieved by providing an easy to use, flexible system and capable of meeting students' needs. This is because a good quality system will help students to accomplish learning tasks and enable them to learn effectively. The positive relationship between system quality and perceived usefulness supports a wide variety of studies in information systems and e-learning systems, including LMS (e.g., Pituch and Lee, 2006; Hussein et al., 2007; Liaw, 2008; Islam, 2011; Fathema and Sutton, 2013; Al-Sabawy, 2013).

H1c: Technical system quality positively influences the use of the e-learning system.

Contrary to our prediction, the results of testing hypothesis (H1c) showed that this hypothesis is not supported by the study sample. In other words, technical system quality did not significantly affect the use of the e-learning system. This indicates that students still use the specific e-learning platform the university adopted, regardless of its quality. A similar insignificant relationship was found in other studies (Wang and Liao, 2008; Urbach et al., 2010; Saba et al., 2012; Sandjojo and Wahyuningrum, 2015; Costa et al., 2016; Aparicio et al., 2017; Cidral et al., 2018; Seta et al., 2018).

The main justification for the non-significant relationship is that aspects of system quality such as ease of use, consistency and integration, system crashes, flexibility, and system features positively and directly affect students' perceived usefulness towards the e-learning system and their satisfaction with it, but not their utilization, as students still need to use the system. This was evidenced by the comments provided by students in their use and dependence on the system to perform learning activities such as submitting assignments, accessing learning resources, accessing timetable, checking announcements made by instructors, and accessing lecture capture. Furthermore, issues like system crashes, for instance, are less important to using the system. On the contrary, it is more important to make students more satisfied, and impact their belief about the usefulness of the system. If the e-learning system, for example, has consistent components and the required features, is flexible and easy to use, then students believe it is useful and aids them to learn effectively and enrich their productivity, then they are more likely to use the system.

7.3.2 Information Quality Hypotheses

Based on the developed model of the study, three constructs are influenced by the quality of information in the e-learning system: perceived satisfaction, perceived usefulness, and system use. Hence, three hypotheses were formulated to reflect the relationships in the model.

H2a: Information Quality → Perceived Satisfaction ☑

H2b: Information Quality → Perceived Usefulness ☑

H2c: Information Quality → System Use ☒

One hypothesis (H2c) was not found to be significant. The results of testing the hypotheses are now presented.

H2a: Information quality positively influences the perceived satisfaction with the e-learning system.

According to the results obtained from data analysis, this hypothesis is accepted. There is a significant relationship between information quality and user satisfaction (*p* value = 0.000). This confirms that information quality is a key determinant of users' satisfaction. For example, information quality aspects such as providing students with sufficient and required information, concise and clear information, understandable and logical organized information, updated content, and providing students with attractive design of content are important aspects to encourage students to have an enjoyable and pleasant experience with e-learning and contribute to their overall satisfaction as the e-learning system satisfies their educational needs.

Justification can be offered by content analysis results of students' comments. Information quality received 65 comments forming 25% of the comments received. The two aspects, understandability and organization of information, and content design quality, together received 55% of the comments under this construct. The issues students face reflect their satisfaction with the e-learning system. Students were not satisfied with the organization of information, and found difficulty in finding the required information, which they considered to be a waste of time and effort. This can be explained as the better the information quality, the more satisfied students are about the e-learning system.

These results corroborate those obtained by Hassanzadeh et al. (2012), who found that information quality has the most direct effect on users' satisfaction. The same relationship was confirmed by other researchers (Ozkan and Koseler, 2009; Aparicio et al., 2017; Cidral et al., 2018).

H2b: Information quality positively influences the perceived usefulness of the e-learning system.

The impact of information on users' perceived usefulness was supported and hypothesis H2b was also accepted. Evidently, aspects of information quality boost the perceived usefulness of the e-learning system. For example, accessibility of information enables students to learn effectively. In addition, organizing the content and information into logical and understandable components in the e-learning system allows students to accomplish their learning tasks quickly. However, overloading students with irrelevant information causes ambiguity. Furthermore, uploading resources regularly, and updating announcements and timetables, strengthens users' belief about the overall usefulness of the system. The result of examining the relationship was clearly interpreted by the comments received, with students pointing out that the effectiveness of learning using the e-learning system depends on updating it with the required information to facilitate their learning. Similar results were achieved by Al-Sabawy (2013) with two samples of staff and academics in an Australian university. Results were also reported in the study undertaken by Hsieh and Cho (2011) in Hong Kong and the study conducted by Chen (2010) in an organizational context of e-learning. For example, information quality aspects, such as providing students with sufficient and required information, concise and clear information, understandable and logical organized information, updated content, and providing students with attractive design of content, are important aspects to improve students' learning performance, helps them learn effectively, and contribute to their overall usefulness with the e-learning system.

H2c: Information quality positively influences the use of the e-learning system.

Unlike user satisfaction and usefulness, findings emerged from testing the effect of information quality on system use failed to gain empirical support. Accordingly, hypothesis H2c was rejected. This negative relationship is interpreted as providing users with high quality information does not influence their use of the e-learning system.

The relationship between the information quality and system's use are divided into two directions in the literature (Eom et al., 2012). Some researchers, in the e-learning context, found that there is a positive relationship between the two (Rai, et al. 2002; Eom et al., 2012; Cidral et al., 2018). On the other hand, other researchers failed to find any causal relationship between information quality and using the system (e.g., McGill and Klobas, 2003; Iivari, 2005; Khayun et al., 2015; Sandjojo and Wahyuningrum, 2015; Kurt, 2018).

Students may not consider that information quality directly impacts their utilization of the e-learning system, but it is significant for creating satisfaction amongst them and their perceptions of usefulness. The main justification for the insignificant relationship can be elicited from content analysis results, where students stated that they depend on the system to access the lecture capture tool available via Moodle, and to use the online submission system in Moodle to submit their assignments. Others do some exams in class and depend on the system to access learning materials during revision periods. Students also stated that lecturer handouts and resources are only available through the system.

7.3.3 Service Quality Hypotheses

The study model presumed that the service quality has a significant impact on three constructs: perceived satisfaction, perceived usefulness and system use. Service quality measures the quality of services the students receive from the IT personnel such as training, online help, and response to queries. Only one hypothesis (H3a) was found to be significant.

H3a: Service Quality → Perceived Satisfaction ☑

H3b: Service Quality → Perceived Usefulness ☒

H3c: Service Quality → System Use ☒

The results of testing the three hypotheses are discussed next.

H3a: Service quality positively influences the perceived satisfaction with the e-learning system.

Statistical results showed that there is a positive relationship between service quality and perceptions of satisfaction. Thus, service quality is a significant construct in students' satisfaction. This result suggests that providing quality services to students may potentially increase their level of satisfaction toward the e-learning system. Thus, it is crucial to have technical personnel who are available when needed, have control over the technology, support students by providing guidance and training on how to use the system, and are able to provide solutions for technical issues students face with the e-learning system, and that can consequently satisfy their need, generate positive feelings, and influence their overall satisfaction with the system.

This result supports other researchers. For example, in the study conducted by Mtebe and Raphael (2018) it was found that service quality is the strongest predictor of satisfaction, (37.8%) of the variances explained by this construct. Another study undertaken in 25 African countries, by Unwin et al. (2010) revealed that the lack of training for students, and the little understanding of staff for most aspects of LMSs, prevented students from achieving the real benefits of using the LMS, and were the reasons for preventing users from full utilization of system features. This result was also supported in other studies (Roca et al., 2006; Sun et al., 2008; Ozkan and Koseler, 2009; Almarashdeh et al., 2010; Al-Sabawy, 2013; Sandjojo and Wahyuningrum, 2015).

H3b: Service quality positively influences the perceived usefulness of the e-learning system.

The outcome of testing the structural model revealed that service quality has no significance influence on users' perceived usefulness. In other words, the quality of services delivered to students by IT personnel does not contribute to students' feelings toward the usefulness of the e-learning system.

One reason for this could be students did not feel the need to contact the IT services regarding issues with the system: for example, in the comments received from students, students pointed out that they faced errors in the system but it easily disappeared without any apparent issue.

Though students appreciated having training or workshops on how to use Moodle, this seems to affect their satisfaction, not their perceptions of the usefulness of the system. In addition, results of content analysis show that 77% of students confirmed that the e-learning system was useful for their study regardless of the services quality by IT staff.

The result that service quality had no significant direct effect on perceived usefulness was inconsistent with prior studies (e.g., Al-Sabawy, 2013 and Landrum et al., 2010); however, compared to their models, this model has investigated additional constructs. Hence, this construct might be an important factor in the success of e-learning systems, but it is not a key factor for students' perceptions of the usefulness of the system compared to the other constructs, which is evidenced from students comments: for example, '*Would be nice if we had a workshop on how to use Moodle in the beginning of the year*' (#258).

Nevertheless, this result was consistent with several studies in the e-learning and information systems arena, with researchers being unable to find any link between service quality and usefulness (Motaghian et al., 2013; Lwoga, 2014; Zaidi et al., 2014; Gorla and Somers, 2014).

H3c: Service quality positively influences the use of the e-learning system.

The results of data analysis revealed the absence of a significant impact of service quality on system use. Thus, hypothesis H3c was not supported. Although the relationship between the two constructs originated from the DeLone and McLean's information systems success model, the majority of studies that employed the two constructs proved empirically the invalidity of service quality in explaining system use (Petter et al., 2008) and this was rather a satisfactory component. Thus, the result of this study in relation to examining the relationship between the two constructs is in line with the majority of previous studies (e.g., Gabel et al., 2008; Urbach et al., 2010; Hassanzadeh et al., 2012; Dwivedi et al., 2013; Seta et al., 2018; Cidral et al., 2018).

A possible reason for the non-significant relationship was proposed by Petter et al., (2008), who stated that service quality is important prior to using the system at earlier stages of implementation but not in the later. Another reason was explained by the researchers, who stated that in a voluntarily system, service quality is not of direct impact to use, contrary to mandatory nature systems where users need to use the system regardless of quality aspects (Eom et al., 2012). However, the use of Moodle in the context of our study is not mandatory. One reason for this insignificant relationship may be because issues of IT services such as availability of IT staff and responsiveness to queries are irrelevant to most students, as they are now familiarized with the e-learning platform and have the required skills, as evidenced from descriptive analysis where 51% of the students have more than two years' experience with the system, and 94.3% have been enrolled in more than one module in Moodle. Furthermore, content analysis results support the descriptive results, as service quality construct received only 2% of students' comments. Consequently, we conclude that students are still using the system regardless of the services they receive from the IT personnel.

7.3.4 Educational System Quality Hypotheses

To fit the context of e-learning, educational system quality was added to the model as a separate construct, as suggested by Hassanzadeh et al. (2012). Educational system quality is related to the existence of features and system functions that facilitate and enhance the learning process. Three hypotheses were formulated.

H4a: Educational System quality → Perceived Satisfaction ☒

H4b: Educational System quality → Perceived Usefulness ☒

H4c: Educational System quality → System Use ☑

Only the third hypothesis gained empirical support. Discussion of the results are now introduced.

H4a: Educational system quality positively influences the perceived satisfaction with the e-learning system.

Statistical results show that there is no significant relationship between the educational quality of the system and perceived satisfaction.

This result is inconsistent with the result obtained by Hassanzadeh et al. (2012) where the researchers developed a model for measuring the success of e-learning in Iranian universities and found a positive and direct influence of educational quality on users' satisfaction. However, the researchers argued in their study that this construct influences users' satisfaction less than the other quality factors. Same results were obtained by Mohammadi (2015).

The finding of our research supports the results of the study conducted by Üstünel (2016), in which the researchers did not find any significant relationship between the existence of interaction components and the diversity of learning styles in the Moodle LMS system with students' satisfaction. A similar finding was obtained, in the well-known model of e-learning satisfaction, by Sun et al. (2008), in which researchers failed to find any significant relationship between interaction tools and perceived satisfaction.

A persuasive reason for this could be elicited from content analysis results, which revealed that there were some issues that students pointed to in their comments regarding ineffective communication in Moodle, and a shortfall in using different learning styles (e.g., videos, images, text, and simulation), which could satisfy students' educational needs. Also, students pointed to issues related to the lack of response to students' messages via Moodle and the need for better chat forums. Clearly, students were not satisfied with these issues, which in turn, negatively reflected their satisfaction towards the educational quality of the e-learning system.

H4b: Educational system quality positively influences the perceived usefulness of the e-learning system.

In the same way, this hypothesis failed to receive empirical support. This apparently contradicts the prior studies of Arbaugh and Benbunan-Fich (2007) and Swan (2007); however, it is in parallel with other studies. For example, in the study of Lim et al. (2007), no relationship was found between educational system quality aspects (communication) and learning performance. Also, in the study conducted by Abbad et al. (2009) and Al-Ammary (2014), no empirical evidence supported the relationship between the existence of interactivity and communication functions between instructor and students and among students, and the usefulness of the LMS and e-learning system respectively.

A reasonable justification for the insignificant relationship in our study is that communication tools, such as discussion forums and chats, are not heavily used by students and instructors compared with the other tools (e.g., online submission system, lecture capture, and quizzes).

Also, students' comments, explicitly, explain the negative relationship: for example, a student commented: '*I think it is useful if they could more use Moodle communicative functions'*. We can conclude that the insufficiency of using interactivity components affects students feeling toward the usefulness of them. Furthermore, the descriptive results (chapter 5, section 5.3) support this justification, as 50.6% of students use the e-learning system to access learning resources and accomplish and submit assignments and quizzes, while only 6.4% use the system solely for accessing learning resources and interacting with instructors and colleagues. The same results were obtained by Üstünel (2016). Students might have felt that the assessment materials e.g., quizzes in the e-learning system, were not an actual evaluation. Thus, it was not so useful to them. Furthermore, 27.2% of the sample use the e-learning system for all the aforementioned. As a result, the majority of students did not value the usefulness of communication features.

H4c: Educational system quality positively influences the use of the e-learning system.

Hypothesis H4c was formulated to examine the influence of the quality of educational aspects on using the e-learning system. Interestingly, there was a statistically significant relationship between the two (p value = 0.000). In other words, aspects of educational system quality such as the existence of communication tools and interactivity features, diversity of learning styles, and providing assessment materials to students (e.g., quizzes, assignments) have a strong influence on utilizing the e-learning system. Thus, students are more likely to use the e-learning system.

Information provided from students' comments supports the finding, whereby students emphasized that they heavily depend on the system to submit assessment materials (e.g., quizzes and assignments) provided by the instructor. Students also need interactive features in the system to communicate with the lecturer directly wherever they need assistance.

As a result, all educational quality aspects contribute to using the e-learning system. This is in parallel with studies that uncovered a positive relationship between the two. For example in the study conducted by Pituch and Lee (2006), system interactivity was found to have a direct influence on using the e-learning system. Also, in Hassanzadeh et al.'s (2012) study, an indirect relationship was found between educational system quality and users' intention to use the e-learning system.

7.3.5 Support System Quality Hypotheses

Support incorporates aspects of the system that support ethical and legal issues, providing information about plagiarism when submitting assignments and copyright law (Khan, 2005) together with popularity of the e-learning system (Ozkan and Koseler, 2009) that has an influence on students using the e-learning system. Three hypotheses were presumed to test the effect of supportive issues on learners' perceived usefulness, satisfaction and use of the e-learning system.

H5a: Support System Quality → Perceived Satisfaction ☑

H5b: Support System Quality → Perceived Usefulness ☑

H5c: Support System Quality → System Use ☑

Discussion of the results of these hypotheses is as follows.

H5a: Support system quality positively influences the perceived satisfaction with the e-learning system.

The direct relation between learners' satisfaction and support was found to be significant. For example, according to Khan (2005) and Ozkan and Koseler (2009), ethical and legal issues are important in creating an effective e-learning environment. Essentially, with the availability of communication facilities (e.g., forums, chat, and email) in the e-learning system, universities should clearly inform students about their data protection policy regarding their personal information, in addition to providing students with sufficient information about behavioural considerations when communicating in the e-learning system.

Also, considering the wealth of resources and information available in the Internet, sufficient information should be provided to students regarding plagiarism rules and regulations when submitting assignments. This can be also delivered by providing extra modules on this matter through the e-learning system. Furthermore, copyright issues, accessibility of content, permission for viewing the course materials, and intellectual property issues should all be clearly delivered to students using the e-learning system.

All these aspects significantly affect students' satisfaction with the e-learning system. This finding concurs with Ozkan and Koseler (2009), where a positive relationship may be found between supportive issues and satisfaction.

H5b: Support system quality positively influences the perceived usefulness of the e-learning system.

After examining the effect of supportive issues on perceived usefulness, hypothesis H5b has gained strong support (*p* value = 0.000). Aspects of ethics and legal issues influence students to learn effectively in the e-learning system and LMS (Khan 2005, Ozkan and Koseler, 2009). This is because more attention has been given recently to ethical and legal issues and new requirements have been introduced for data protection legislation. Further, considering the existence of communication facilities (e.g., forums, chat, and email), data generated from chat and forums may express personal opinions, personal data, and personal biases that students are unlikely to want the outside world (through search engines) to know. Thus, providing information prior to using the e-learning system can increase their awareness and significantly influence their perceptions towards the overall usefulness of the system. This relationship was not empirically tested in prior studies; however, evidence from the literature (Khan, 2005; Ozkan and Koseler 2009; Navimipour and Zareie, 2015) can be compared to our results.

H5c: Support system quality positively influences the use of the e-learning system.

Hypothesis H5c has also gained strong statistical support (p value = 0.000). In parallel with qualitative data, students' comments support the empirical results. Students emphasized that aspects of data protection influence their use of the system. For example, a student commented: '*The forum is not anonymous and I am too intimidated to post anything on it'* (#195). Khan (2005) identified an eight dimension framework for evaluating e-learning systems, and ethical was among these.

Another aspect of supportive issues that also affects the utilization of an e-learning system is the popularity of the e-learning system. In the context of the study, there are other e-learning systems in the university. Among these system, Moodle is the dominant and most popular system available to students, providing them with access to most learning tools. The popularity and trends significantly influence students' usage (Ozkan and Koseler, 2009). The role of the institution in promoting and supporting students and instructors is essential. Beatty and Ulasewics (2006) reported that if the institution decided to utilize an LMS, then integral efforts among IT staff, faculty advisory committee, and support services should take place.

This hypothesis was not tested empirically in the prior literature; however, the result supports the studies of Khan (2005), Beatty and Ulasewics (2006), and Ozkan and Koseler (2009) who explicitly emphasized the role of the supportive issues, such as ethics and promotion with enhancing the usage of an LMS.

Therefore, support system quality is worthy of attention, and may enhance the perceived satisfaction, perceived usefulness and use of the e-learning system.

7.3.6 Learner Quality Hypotheses

Learners are characterized in our model by five quality features: learner's behaviour, attitude, and anxiety toward utilizing e-learning, in addition to learner's previous experience, and learner's self-efficacy which have implications on using the system, perceive usefulness and satisfaction with the e-learning system. This study proposed three hypotheses and tested them to explain the relationships between this construct with satisfaction, usefulness and use of the e-learning system.

H6a: Learner Quality → User's Satisfaction ☑

H6b: Learner Quality → Perceived Usefulness ☑

H6c: Learner Quality → System Use ☑

The results of testing the three hypotheses support the three hypotheses, indicating that the quality of learner is a highly important factor in the success of e-learning. Following is a discussion of the results.

H6a: Learner's quality positively influences the perceived satisfaction with the e-learning system.

The results of path analysis between learner construct and user's satisfaction with the e-learning system provide a strong support for hypothesis H6a (*p* value = 0.003), and hence, it was accepted.

The results are in parallel with previous studies of Üstünel (2016), Ozkan and Koseler (2009), Sun et al., (2006) and Chen and Yao (2016) who employed this construct in their models of LMS and other e-learning systems evaluation.

Among the learners' characteristics employed in our model to represent this construct, learners' attitude has been found to be the most significant factor in this dimension. This finding supports Webster and Hackley (1997), who stated that "the successful implementation of any technology depends on factors related to users' attitudes" and in parallel with Piccoli et al., (2001) where they found learners who have positive attitude toward the LMS are more satisfied with it. The result supports studies in literature (Davis et al., 1989; Zoltan and Chapanis, 1982; Gelderman, 1998). However, the studies of Gunawardena et al. (2010), Liaw and Huang (2013), and Chen (2007) found self-efficacy to be the most powerful determinant of satisfaction.

The finding confirms the vital role that the learner plays in the success of e-learning. Learners, who have a positive attitude toward using e-learning systems are more satisfied with the system. Since the majority of the study sample (531 out of 563) have been enrolled on more than one module during their academic study via Moodle, they are considered to be experienced users (52% of the sample have more than two years' experience with the system). Students' experience and familiarity with the system, and the ability to use the system and perform tasks (self-efficacy) can stimulate their positive attitudes toward the e-learning system, and thus, their overall satisfaction with it.

H6b: Learner's quality positively influences the perceived usefulness of the e-learning system.

Analysis of results confirms the positive relationship between learner's construct and the perceived usefulness of the e-learning system (p value = 0.000).

Qualitative findings from content analysis support the quantitative results of path analysis between the two factors. For example, students' positive attitudes toward the technology can cause the students to have positive feelings about the usefulness of the system. In relation to this, a student stated that '*I definitely like the paperless assignment submission system in Moodle- during my study where we were required to submit both an electronic copy and a 'hard' copy...'*

In addition, self-efficacy (i.e., ability to perform tasks) may enhance students' perceived usefulness as they are capable of dealing with the system and experience lower complexity. Furthermore, learners' previous experience allows students to accomplish their learning tasks more efficiently. As a result, students perceived the e-learning system to be useful and to help them to learn effectively.

The result is consistent with other researchers who investigated, empirically, the relationship between different learner's sub-dimensions and perceived usefulness. For example, Lee et al. (2013) found a significant relationship between previous experience and perceived usefulness. Fathema et al. (2015) found self-efficacy to be a significant determinant of perceived usefulness of the LMS. Similar results were consistent with the findings of other researchers (Roca et al., 2006; Liaw, 2007; Wu et al., 2010; Al-Mushasha, 2013; Al-Ammary et al., 2014).

H6c: Learner's quality positively influences the use of the e-learning system.

Similar to the results of previous hypotheses H6a and H6b, hypothesis H6c has also gained empirical support (p value = 0.000), which indicates a strong influence of learners' aspects on their usage of the e-learning system.

The effect of the learner quality construct on system usage can be explained by considering the different aspects of the learner on using the system, supported by students' comments. For example, students with a positive attitude towards technology and e-learning systems are more likely to use it. One student stated in relation with this '*E-learning systems are essential in education today; a place to access files electronically is necessary in* *successfully passing a course'*. This also confirms the importance of users' positive attitude toward technology explained by Liaw et al. (2007): "Indeed, no matter how advanced or capable the technology is, its effective implementation depends upon users having a positive attitude toward it".

Students' previous experience positively influences students' familiarity with the system, which can minimize the effort they invest when they navigate or when they face obstacles with the system, and this makes them less anxious and more comfortable with it. A student commented in this regard: '*I have used Moodle before, it is very easy to use'*.

Moreover, self-efficacy can improve students' confidence when using the e-learning system, since they will find it easy to use. Not only will they use the system, but they will recommend it to others. A student commented in relation to this: '*Moodle is amazing and has shaped my learning at Warwick. It is fun and easy to use, and I would recommend Moodle to everyone'*.

The relationship between the learner as a stand-alone construct and system use has not been tested before, although similar results were reported in several studies between learner sub-dimensions and the use of the system, or the intention to use the system (Sánchez and Hueros, 2010; Mohammadi, 2015; Kim and Park, 2018; Teo et al., 2019)

7.3.7 Instructor Quality Hypotheses

The study model introduces instructor quality as a separate construct influencing learners' perceived satisfaction and usefulness and use of the e-learning system. Instructor's enthusiasm and recommendation about using e-learning, interactive communication and prompt responsiveness to learners via the e-learning system, together with instructors' positive attitude toward utilization of e-learning, affect the success of the e-learning system. Hence, three hypotheses were formulated.

H7a: Instructor Quality → User's Satisfaction ☑

H7b: Instructor Quality → Perceived Usefulness ☑

H7c: Instructor Quality → System Use ☒

The follow is a discussion of the results of testing the hypotheses.

H7a: Instructor's quality positively influences the perceived satisfaction with the e-learning system.

Statistical results support hypothesis H7a. Since the instructor is the key person of importance to learners in the e-learning environment (Cheng, 2012), students' satisfaction with e-learning is positively influenced by the instructor quality. In the study conducted by Kim et al. (2012), researchers stated that "The instructor is the most important success factor in e-learning... Instructors increase user satisfaction and encourage students to become engaged in various learning opportunities.”

The qualitative data provides further support for the statistical results. The influential role of instructors in online environment was explained in the students’ comments. One student stated: ‘*Moodle is like many other education facilitating sites, how effective it is at supporting learning depends on how well academics use and update’*. Another student commented that ‘*More timely responses to forum questions would be helpful’*. When instructors communicate with students, respond rapidly to learners via the e-learning system, exhibit more positive attitudes and enthusiastic toward using the e-learning system, these can positively impact learners’ satisfaction with the e-learning system.

The positive relationship between instructor and users’ satisfaction is consistent with other studies (Selim, 2007; Sun et al., 2008; Ozkan and Koseler, 2009; Lwoga, 2014; Zhao et al, 2019; Mtebe and Raphael, 2018; Cidral et al., 2018).

H7b: Instructor’s quality positively influences the perceived usefulness of the e-learning system.

Instructor’s quality on perceived usefulness has also gained empirical support. Essentially, instructors can improve students’ learning performance, help them learn effectively and achieve educational objectives by facilitating communication and interaction with students in the e-learning system and timely responding to them. In addition, instructors’ enthusiasm and positive attitude may immerse students in these interactions, in turn they can experience flow in the learning process (Choi et al, 2007; Cheng, 2012). All these aspects are valuable and important to students and thus, can stimulate their satisfaction and perceived usefulness toward the system (Sun et al., 2008; Lee et al., 2009). This relationship was in parallel with qualitative data and was explicitly stated in students’ comments: ‘*…but I think it is useful if they could more use Moodle communicative functions’*. Another student added: ‘*I am satisfied with it perhaps they could include a communication features with the lecturer directly where ever you need assistance’*.

The finding of the study in relation to this hypothesis is consistent with other studies (Lee et al., 2009; Tseng et al., 2011; Cheng, 2012; Loh et al., 2016; Abbas, 2016).

H7c: Instructor’s quality positively influences the use of the e-learning system.

Unexpectedly, instructor’s communication, responsiveness, and attitude toward the e-learning system did not affect students’ use of the system. This result contradicts with prior studies where support was found on the relationship between instructor on usage or intention to use the e-learning system (Lee et al., 2009; Nair et al., 2015; Abbas, 2016). However, it is consistent with Zhao et al. (2019), where no support was found between instructor and continued intention to use.

A possible justification for this insignificant relation could be elicited from qualitative data. Students are very dependent on Moodle to access the resources the instructors upload. One student stated: '*it's the only place to access the resources lecturers upload'*. Also, students use Moodle to submit assignments using the online submission system and to check timetable. Furthermore, to access the other tools available via Moodle, such as, the lecture capture, a student commented: '*.....I am personally heavily dependent on lecture capture for my education'*.

In addition, several students pointed that '*the issue is not with Moodle*', '*it is more with the lecturers putting things in the wrong place*', '*lecturers need to know how to organize it*', and '*lecturers do not respond to messages*'. Students might feel that instructors do not have control over the system and are not actually enthusiastic in utilizing the full features available in the system. Thus, aspects related to instructors were strongly related to their satisfaction and perceived usefulness of the system but not their utilization of it. As a result, they use the e-learning system regardless of instructors' recommendation, interaction and communication.

7.3.8 Perceived Satisfaction Hypothesis

Perceived satisfaction is proposed to significantly and directly affect the benefits of e-learning.

Perceived Satisfaction → Benefits ☑

The hypothesis is discussed below.

H8: Perceived Satisfaction with the e-learning system positively influences students' benefits

This hypothesis has gained strong support. Thus, the more satisfied the user is, the greater the benefits and impacts on students will be achieved. In other words, if students feel satisfied with the e-learning system, they also experience an increase in productivity. Although Saba (2012) reported conflicting finding, hypothesis H8 is supported and has a large effect. The significant relationship supports the study of Aparicio et al., 2017 in which user satisfaction was found to positively influence the individual impacts of an e-learning system with large effect. The same result was found in the study of Hassanzadeh et al. (2012) who extended the DeLone and Mclean IS model and found that students' satisfaction had a positive impact on the individual benefits ($\beta = 0.66$) and is in line with the majority of studies on e-learning (e.g., Wu and Wang, 2006; Urbach et al., 2010; Seta, 2018; Cidral et al., 2018).

7.3.9 Perceived Usefulness Hypotheses

Perceived usefulness was selected as a central construct in the model of the study. It was hypothesised to directly affect perceived satisfaction, use of the system and benefits. Perceived usefulness is related to learners' beliefs about that using the e-learning system would enhance their learning performance (Davis et al., 1989).

H9a: Perceived Usefulness → Perceived Satisfaction ☑

H9b: Perceived Usefulness → System Use ☑

H9c: Perceived Usefulness → Benefits ☑

Further discussion of the results of these relationships is now introduced.

H9a: Perceived Usefulness positively influences the perceived satisfaction with the e-learning system.

The results of the study strongly support hypothesis H9a with (*p* value = 0.000). Thus, perceived usefulness is a key determinant of students' satisfaction. Results of content analysis are in parallel with this finding and support this relationship. For example, a student stated: '*Moodle aids me with my learning as well as understanding with individual modules'*.

Clearly, students would feel satisfied if they feel that the system enhances their learning performance and activities, help them to accomplish their tasks easily and smoothly with less effort, hence learn more effectively. The results overlap with several e-learning studies that have investigated this relationship (Sun et al., 2008; Almarashdeh et al., 2010; Islam, 2011; Al-Sabawy, 2013; Lwoga, 2014; Ghazal et al., 2018).

H9b: Perceived Usefulness positively influences the use of the e-learning system.

Hypotheses H9b is strongly validated; perceived usefulness has a direct impact on system use. Qualitative data also supported this finding. One student commented: '*By far, one of the most efficient and useful e-learning systems that I have come across. Helps achieve almost all the learning goals set in the course'*.

The e-learning system provides learners with useful tools that could improve their learning performance. If students perceived the e-learning system to be useful to them, they are more likely to use it. This result is consistent with various e-learning studies (Pituch and Lee, 2006; Raaij and Schepers, 2008; Šumak et al., 2011; Islam, 2012; Islam, 2013; Sandjojo and Wahyuningrum, 2015).

H9c: Perceived Usefulness positively influences students' benefits

Hypothesis H9c is related to the individual impact resulting from users' perceptions towards the usefulness of the system. The statistical results strongly support this hypothesis (*p* value = 0.000).

In fact, e-learning systems offer several useful facilities that may assist students' in their study, such as group discussion and communication facilities, online quizzes, assignment submission, and availability of learning materials. These are very useful features for students that would influence their perceived usefulness of the system. Based on these aspects, it is expected that the usefulness of the e-learning system to positively increase students' benefits. In other words, if students strongly believe that using the e-learning system is useful then benefits may be achieved at different levels, such as increasing their knowledge and be successful in the modules, achieving the learning goals of the modules, improving their learning, and saving time and costs by making the learning resources and materials available in the system.

This finding is in parallel with previous studies that have highlighted the direct significant relationship between usefulness and net benefits (Hwang et al., 2008); usefulness and organizational benefit (Park et al., 2011); usefulness and individual impact (Lee et al., 2011); usefulness and both individual and organization impacts (Hasan et al., 2017).

7.3.10 System Use Hypothesis

System usage is proposed to significantly and directly affect the benefits of e-learning.

System Use → Benefits ☑

The discussion is presented below.

H10: The use of the e-learning system positively influences students' benefits

In view of the fact that using e-learning systems is positively related to individual's benefits, hypothesis H10 has gained empirical support. If using the e-learning system is in line with students' needs, then students will be more successful in the modules, interaction and communication are easier, and learning goals are achieved. Furthermore, the e-learning system will save their time in searching for materials and cut down expenditure such as paper. Thus, the higher the usage of the e-learning system, the greater the benefits that are achieved. The result is in line with the literature (e.g., Urbach et al., 2010; Aparicio et al., 2017; Cidral et al., 2018).

Summary of hypotheses results

As can be seen from the discussion above, most of the hypotheses in the model gained statistical support and were verified.

To summarize, seven variables were the determinants of e-learning perceived satisfaction: technical system quality, information quality, service quality, support system quality, learner quality, instructor quality, and perceived usefulness. These together explained 71.4% of the variance of satisfaction. Among the seven variables, learner quality has the strongest influence on perceived satisfaction with 49% of the variance explained by learner quality, 27.7% was explained by perceived usefulness, and the rest of the variance was explained by the other variables with support system quality being the least.

Five antecedents were found to be the determinants of e-learning perceived usefulness: technical system quality, information quality, support system quality, learner quality, and instructor quality. The five variables explained together 54.2% of the variance of perceived usefulness. Among these, learner quality explained 38.9% of the variance, support system quality contributed with 17.9%, information quality contributed with 14.6% followed by instructor and the weakest influence was technical system quality.

For the e-learning system use, 34.1% of the variance was explained by the four variables: educational system quality, support system quality, learner quality and perceived usefulness. The strongest influence was obtained by perceived usefulness contributing with 43.2% of the variance, followed by learner quality with 35.2%, educational system quality with 14.3, and the rest was explained by support system quality.

Finally, benefits of e-learning system on users are determined by three variables: perceived satisfaction, perceived usefulness and system use. These three variables together explained 64.7% of the variance of e-learning benefits on users. The strongest path was from perceived usefulness contributing with 57.3%, followed by perceived satisfaction with 38.8%, and the weakest effect was obtained from system use.

A summary of the results of hypotheses testing results can be depicted in Figure 7.42 where a dashed line indicates the absence of statistical support for the relationship between the two constructs.

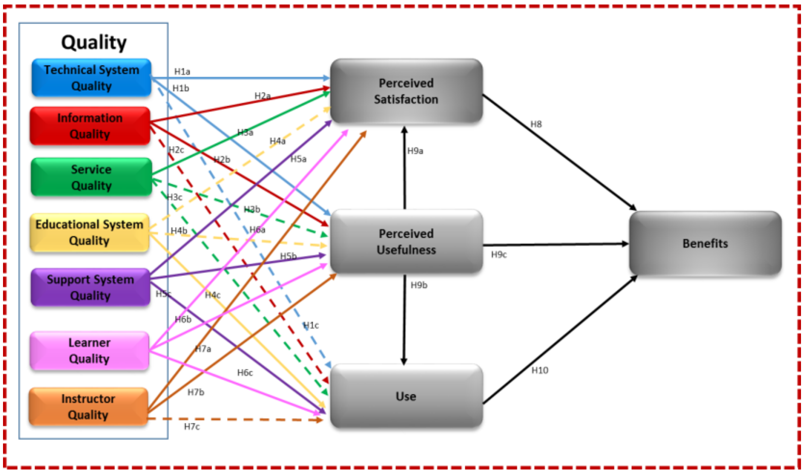


Figure 7.42: Model Hypotheses Results Summary

7.4 Discussion of Content Analysis Results

Qualitative data were collected from students' comments at the end of the survey. Thematic analysis was utilized to analyse data. The results obtained from content analysis were in parallel to, and supported the quantitative results, and provided additional insight into these results. The themes found were related to issues faced which influence the success of the e-learning system. Based on the results obtained in chapter 6 (section 6.3.3), the factors influencing the success of e-learning system based on students' comments were around these themes: technical system quality, information quality, satisfaction, educational system quality, use, usefulness, instructor quality, benefits, learner quality, and service quality. However, students' comments revealed some aspects related to these factors that were not considered in the study model. Regarding the quality of **instructor**, the most important issues students faced were control over technology and instructors' self-efficacy. While control over technology is related to the knowledge necessary to use the technology, self-efficacy is the ability and confidence required to achieve the desired performance and successfully attain the education goals (Honicke and Broadbent, 2016).

Students claimed that instructors do not utilize the features available in the system because they do not have enough knowledge, they do not update the information, do not respond to messages in the system, and do not know where to upload information. Consequently, interaction between students and instructors was limited from one hand, and from the other hand, students were overwhelmed with disorganized, outdated information and spent a lot of time trying to find information. Students highlighted this factor with 13 comments received around this issue. For example, '*I think the issue with Moodle is the difficulties in finding things; has more to do with the lecturers putting things in the wrong place rather than a problem with Moodle'*.

Instructors' control over technology and self-efficacy are significant sub-dimensions to measure and examine in relation to instructor's quality construct in our model. Hence, when instructors have competence and control over the technology, they are more likely to use it effectively and efficiently (Bakke and Henry, 2015).

Regarding **technical system quality**, the results of qualitative and quantitative data were consistent regarding some indicators and inconsistent with others. Initially, 11 indicators were employed to measure this construct. Quantitative results excluded 6 sub-dimensions out of the 11 because they failed to meet the minimum requirements. In comparison, qualitative data revealed 9 sub-dimensions in relation to this construct.

Two sub-dimensions were not identified from content analysis results (i.e., system availability and security), and were also excluded from quantitative results. A possible reason for this could be that aspects of system availability and security are not significant to the study sample, as Moodle is always available for students to perform learning activities, it is secure, and access is granted only with log in details and password. Such issues may be more convenient for investigating the success factors in developing countries where e-learning is still in its infancy and experience challenges, in infrastructure and connectivity, unique from developed countries (Bhuasiri et al., 2012).

Although ease to learn, fulfilment, and personalization were excluded from our model based on quantitative results, they received students' attention (7 comments received related to these three sub-dimensions). However, most students, based on the quantitative results, considered these three indicators insignificant.

Regarding the remaining sub-dimensions of technical system quality, system features dominated students' comments and clearly appears to influence the success of the system. Evidently, students depend on mobile devices and reading tablets to access the system. Students had issues of platform incompatibility, suggesting that the system was better optimised for PCs rather than other operating systems and devices. Some uploaded materials and resources are not accessible and compatible with most devices, thus limiting the accessibility of the system whenever needed and forcing them to use PCs.

Students pointed to some missing system features in the e-learning system:

1. Notifications on what has been uploaded and updated, text / notification sent to mobile, and more noticeable notifications;
2. Personalized frequently-access section to save their time in finding the needed information;
3. Search tool within the page content rather than just page headings;
4. Integrated calculator to show the results and average grade.

In relation to system features and functions, students appreciated the availability of lecture recordings through lecture capture, although lecture capture is not part of Moodle itself (rather it is a tool accessible via Moodle). The existence of lecture recordings in the e-learning system significantly affects their utilization and dependence on the system, fostering self-paced learning so they learn at their own convenience, and transcending geographical boundaries (Brady et al., 2010). Additionally, students find it useful to go back to the lectures' recordings during revision time.

The results also revealed some obstacles most of students faced related to navigation and browsing; poor, unattractive and non-intuitive design, resulting in increasing the time clicking around many pages searching for the required information.

Another important issue students faced was the inconsistency between the different modules, which causes confusion to students, impedes them from achieving some tasks, and burdens them to familiarize themselves with the structure of each module.

Regarding **information quality**, students' comments overlapped with information quality sub-dimensions. Students pointed out that content is outdated and information, announcement, resources all need to be updated. Information lacks organization and clarity. Also, the difficulty in finding the required information dominated students' comments. This again emphasises the very important role of instructors' control over technology in success of the e-learning system. Instructors need to have training to use the system and be aware of the features and functions available that could enhance students' learning performance.

Regarding **educational system quality**, content analysis results support the quantitative part in all sub-dimensions. Students agree that more interactivity components are necessary and useful for their learning. Students encounter problems related to ineffective communication and lack of responses to messages. All students' comments received regarding this aspect showed that they appreciated having interactivity and communication features. Furthermore, the diversity of learning styles that accommodate different learners was an important factor to students.

Regarding the **learner quality** dimension, 3 sub-dimensions were common to both results. Learners' attitudes, previous experience and self-efficacy are all important aspects that influence the usage, perceived usefulness and satisfaction with the system. Students' comments showed the positive attitudes students have toward utilizing e-learning system in their study. Students' ages were between 18-30 years old, at undergraduate or postgraduate level, and the majority were experienced and familiar with computers and the Internet and capable of utilizing technology in their learning. However, computer anxiety was not identified from content analysis results.

Supportive system issues were consistent in both quantitative and qualitative results. Students revealed that the forum is not anonymous, and this might prevent students from posting anything. This demonstrates that ethical and legal issues should be taken into consideration and students should be clearly informed about the privacy of their personal data.

Regarding **service quality**, students' comments were around one sub-dimension only that is providing guidance services and training on how to use the system. This supports the quantitative results in parallel with the literature, where training was found to be an important factor in e-learning success. However, issues of IT services availability, fair understanding, and responsiveness were not identified from content analysis results.

Students expressed their perceptions about the **usefulness**, **satisfaction** and **use** of the system with regard to the different quality measures.

In relation to **benefits**, students' comments revealed that the obstacles they face while using the system take considerable time from them, thus the system did not save their time. However, the system improved their learning performance and helped them to achieve learning goals and be successful in the modules. Students did not comment regarding easier interaction and communication, and this was in parallel with the statistical results, where this indicator was excluded from our model as it did not achieve the required level of reliability and validity. Apparently, interactivity components were not active enough to enhance and ease their communication with the instructor and each other.

Summary of the main issues students face with the e-learning system:

1. Difficulty in finding the required information, which confuses students and wastes their time in searching for the information;
2. Difficulty in navigation;
3. Poor, non-intuitive and non-attractive design;
4. Inconsistency of layout across the different modules;
5. Missing useful and helpful system features:
   - notifications;
   - search function;
   - personalized frequently-accessed section;
   - platform incompatibility with mobiles and other devices;
   - providing lecture materials in a format that is accessible by most devices;
   - integrated calculator to show the results 'grades' in all modules;
6. Poor organization and structure of the content;
7. Outdated content and information;
8. System crashes;
9. Lack of effective and interactive communication;
10. Lack of timely, helpful instructors' feedback to students' questions and inquiries;
11. Lack of training for instructors about the features provided and how to organize materials and content uploaded in the system;
12. Lack of training and induction for students on how to use the system.

Table 7.63 provides a summary for the differences between the factors arising from quantitative and qualitative results.

Themes	Subthemes	Quantitative	Qualitative
Technical System Quality	Ease of Use	✓	✓
	Ease to Learn	×	✓
	User Requirements	✓	✓
	System Features	✓	✓
	System Availability	×	×
	Flexibility	✓	✓
	Integration and Consistency	✓	✓
	System Reliability	×	✓
	Fulfilment	×	✓
	Security	×	×
	Personalization	×	✓
Information Quality	Sufficiency of Information	✓	✓
	Accessibility of Information	✓	✓
	Usability of Information	✓	✓
	Conciseness and Clarity of Information	✓	✓
	Understandability and Organization	✓	✓
	Up-to-date Content	✓	✓
	Content Design Quality	✓	✓
Service Quality	Providing Guidance Services	✓	✓
	Providing Help	✓	×
	Staff Availability	✓	×
	Fair Understanding	✓	×
	Responsiveness	✓	×
Educational System Quality	Interactivity and Communication Features	✓	✓
	Effective Communication	✓	✓
	Diversity of Learning Styles	✓	✓
	Assessment Materials	✓	✓
Support System Quality	Ethical Issues	✓	✓
	Behavioral Considerations	✓	×
	Legal Issues	✓	✓
	Promotion of the E-learning System	✓	✓
Learner Quality	Learners' Behavior	✓	✓
	Learners' Attitude	✓	✓
	Learners' Anxiety	✓	×
	Learner's Previous Experience	✓	✓
	Learner's Self-Efficacy	✓	✓
Instructor Quality	Subjective Norm	✓	×
	Instructor's Control Over technology	×	✓
	Instructor's Self-efficacy	×	✓
	Instructor's Enthusiasm	✓	✓
	Instructor's Responsiveness	✓	✓
	Instructor's Interactive Communication	✓	✓
	Instructor's Attitude	✓	✓
Perceived Satisfaction	Enjoyable Experience	✓	✓
	Providing Educational Needs	✓	✓
	Satisfaction with System Performance	✓	✓
	Overall Satisfaction	✓	✓
Perceived Usefulness	Accomplishing Learning Tasks	✓	✓
	Improving Learning Performance	✓	×
	Effective Learning	✓	✓
	Overall Usefulness	✓	✓
System Use	Dependence on the System	✓	✓
	Regular Use	✓	✓

	Nature of Use	✓	✓
	Frequency of Use	✓	✓
Benefits	Increased Knowledge	✓	✓
	Improved Learning Process	✓	✓
	Easier Interaction and Communication	×	×
	Time and Cost Saving	✓	✓
	Achieving Learning Goals	✓	✓

Table 7.63: Summary of the differences between the factors from quantitative and qualitative results

As can be seen from table 7.63, results from the quantitative and qualitative parts of the study are consistent and confirm the validity and reliability of these measures to evaluate the success of e-learning. Two sub-dimensions that appeared from students comments related to the instructor quality were not considered in the model: control over technology and self-efficacy. Two sub-dimensions eliminated from the model were significant and identified in students' comments: personalization and fulfilment. Three sub-dimensions were eliminated and were consistent with qualitative results: system availability, and security from technical system quality construct and easier interaction and communication from benefits.

7.5 Model Performance Discussion

This section discusses the performance of the model and conducting a comparison of the model performance with the performance of other models developed by prior studies.

Although a considerable number of research studies have extended the DeLone and McLean information systems success model and attempted to evaluate e-learning systems success, this model is often only partially tested. In addition, few of those studies have accounted for all aspects of quality that fit the context of e-learning. The developed model performance is measured by the amount of variance explained R squared (R^2) in the dependent variables (i.e., perceived satisfaction, perceived usefulness, use, and benefits). R^2 as explained earlier in chapter 6 (section 6.3.2) is a "statistical measure that represents the proportion of the variance for a dependent variable that is explained by an independent variable" (Fairchild et al., 2009).

R^2 = Explained variation / Total variation

R^2 is between 0 and 100% where:

- 0% indicates that all independent variables in the model explain none of the variability of the dependent variable;
- 100% indicates that all independent variables in the model explain all the variability of the dependent variable;
- Any amount between 0-100% means that all independent variables explain the dependent variable by that certain amount and the rest are explained by other variables outside the model.

The study model has substantially explained the variance of e-learning satisfaction, moderately to substantially explained the variances of the dependent variables perceived usefulness and benefits, and moderately explained use can be seen in Table 7.64 below.

Independent	Dependent	R^2	R power
Technical system quality Information quality Service quality Instructor quality Learner quality Support system quality Perceived usefulness	**Perceived Satisfaction**	**71.4%**	**Substantial**
Technical system quality Information quality Support system quality Learner quality Instructor quality	**Perceived Usefulness**	**54.2%**	**Moderate to substantial**
Perceived usefulness Learner quality Educational system quality Support system quality	**Use**	**34.1%**	**Moderate**
Perceived usefulness Perceived satisfaction System use	**Benefits**	**64.7%**	**Moderate to substantial**

Table 7.64: Amount of variances explained in the dependent variables in the study model

The amounts of variances explained for the dependent variables in our research model are deemed to be one of the study contributions, since the results outperform existing models that extended the DeLone and McLean model to evaluate the success of e-learning systems. The results also support the call for further research and investigation of e-learning quality factors to increasing the explanatory power of exiting models that address the success of e-learning systems. Table 7.65 shows selected studies based on their utilizing of the DeLone and McLean information systems success model in the evaluation of LMSs. Furthermore, less variation in R^2 values is found among the dependent variables in this study model compared with prior models where high variance explained R^2 in one dependent variable was at the expense of another variable (i.e., lower R^2).

The findings of this study suggest that the selected variables are significant predictors toward e-learning perceived satisfaction, perceived usefulness, use, and benefits. Thus, the study model is more capable to explain success dimensions of e-learning than prior models.

Model	Independent Variables							Variance Explained R^2			
	TSQ	INQ	SRQ	ESQ	SUP	LER	INS	SAT	USF	USE	BNT
Ozkan and Koseler, 2009								76.9%	None	None	None
Chen, 2010								67.9%	47.03 %	52.1%	20.3%
Klobas and McGill, 2010								57%	None	17%	31%
Ramayaha et al., 2012								45%	None	None	None
Hassanzadeh et al., 2012								65%	None	28%	65%
Lwoga, 2014								68.9%	57.1%	None	None
Sandjojo & Wahyuningrum 2015								45.4%	22%	42.7%	53.8%
Mohammadi, 2015								22.2%	2.3%	73.7%	None
Marjanovic et al., 2016								14.3%	None	12.7%	44.2%
Aldholay et al., 2018								42.8%	None	16.8%	61.2%
Cidral et al., 2018								57.1%	None	32.2%	52.5%
Mtebe, 2018								34.3%	None	None	None
Study Model EESS								**71.4%**	**54.2%**	**34.1%**	**65%**

Table 7.65: The explained R2 variance comparison among studies that employed DeLone and McLean model to evaluate the success of LMS

Note: SQ: system quality; INQ: information quality; SRQ: service quality; ESQ: educational system quality; SUP: support; LER: learner; INS: instructor; SAT: satisfaction; USF: usefulness; USE: use; BNT: benefit

In terms of model prediction power, the model shows strong predictive power among each of perceived usefulness, perceived satisfaction, and benefits, and moderate predictive power for e-learning system use.

Model fit criteria SRMR and RMS theta met the threshold values and indicate a well-fitting model (see chapter 6, section 6.3). Also, Goodness-of-Fit (GoF) value was 0.49 which is deemed large.

Based on all of the above results, the indicators, the constructs and the whole model is valid, reliable and applicable to evaluate e-learning systems success with a good overall fit and shows a considerable percentage of variance explained among the dependent variables. Results could be considered as novelties as the model outperforms the existing models.

7.6 Chapter Summary

This chapter served to shed light on and discuss in more details the results obtained in chapter 6. The results obtained from the measurement model and the structural model were discussed in sections 3 and 4. A summary of the results was given at the end of each section. Further details about the qualitative data obtained from students were discussed in section 4. The performance of the model in terms of the variance explained among the dependent variables, the predictive power of the dependent constructs, and the model fit criteria were discussed in section 5. Additionally, a comparison was conducted between this model and prior models that adopted the DeLone and McLean information systems success model in the context of e-learning. The results obtained from quantitative and qualitative data supported the proposed model.

CHAPTER EIGHT: CONCLUSION AND FUTURE WORK

8.1 Chapter Introduction

The previous chapters were distributed as follows. Chapter 1 was allocated to the research introduction, background, motivation, problems, research questions, and objectives. Chapter 2 was allocated to the literature review. The model of the study was proposed and established in chapter 3. Chapter 4 presented the methodology, sampling and data collection methods. Chapter 5 presented the preliminary data analysis. Chapter 6 was allocated to the measurement model, structural model, and content analysis methodologies and results. Chapter 7 discussed the results found in chapter 6. Finally, a conclusion is given in chapter 8, organized into three sections: first, conclusion; second, research contribution; third, limitations and recommendations for future work.

8.2 Conclusion

The research aimed to investigate the factors that are to be considered when evaluating e-learning system success. Based on the aims of the research, an e-learning success model was developed that incorporates these factors. To fulfil the research aim and to answer the research questions, the research proposed four objectives. Figure 8.43 explains each research question and how it was answered in this research.

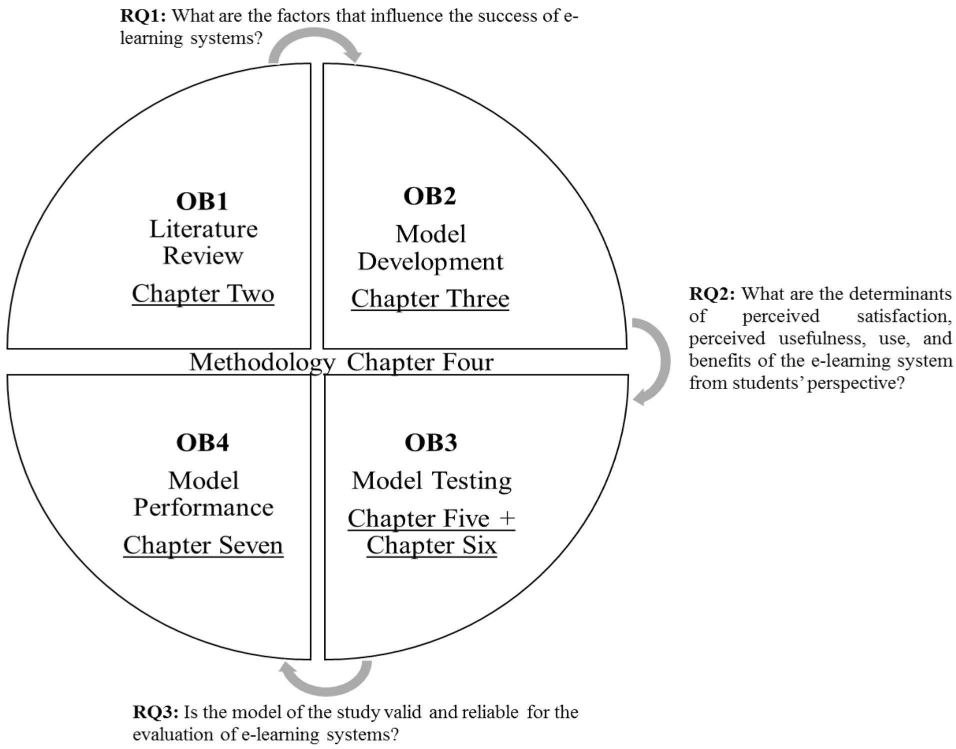


Figure 8.43: Research questions and research objectives across the research

The first research question RQ1 “What are the factors that influence the success of e-learning systems?” was addressed in two stages as follows.

The first stage involved conducting an intensive literature review to identify the approaches for evaluating e-learning systems success. A total of 140 papers published in leading journals were reviewed. A selection of these papers was made based on their novelty, confidence in their empirical results, and the area of concern. Four approaches were identified from the literature. These four approaches were analysed so as to provide a theoretical basis for the research: DeLone and McLean’s information systems success model (D&M model); the Technology Acceptance Model (TAM); the User Satisfaction Models; and E-learning Quality Models.

In order to provide a general comprehensive definition of e-learning success measurements, the four approaches found in the literature for measuring the success of information and e-learning systems were considered. Some were used to identify the main themes of the model, while others served to determine the corresponding sub-themes. The study model mainly adopted the D&M model and extended it to include factors from the other theories and models to fit the context of e-learning. Different perspectives have been considered in the model in relation to quality, acceptance, user beliefs, social factors, and the benefits of using the e-learning system. These dimensions encompass the main components of the existing four approaches (see Figure 3.24, chapter 3).

The second stage was achieved by organizing these dimensions and sub-dimensions into a multi-dimensional conceptual model for evaluating e-learning systems success (EESS model) (see Figure 3.25, chapter 3). In the EESS model, 11 dimensions were identified. Of the 11 dimensions, six were adopted from the D&M information systems success model, two from TAM, and three from e-learning satisfaction models. The e-learning quality models were used to identify some of the corresponding sub-dimensions in our model. The EESS model is comprehensive: it is not based on the number of constructs but on providing a holistic picture and different levels of success related to broad range of success determinants, rather than focusing on a specific construct, and is an original contribution to knowledge.

The second research question “What are the determinants of perceived satisfaction, perceived usefulness, use, and benefits of the e-learning system from students’ perspective?” was addressed through two stages: model development and model testing.

Stage one involved developing the model. Relationships between the model’s constructs were established. Twenty-six (possible) relationships supported by literature and theoretical underpinning were hypothesised. The present study proposed the model for evaluating the success of e-learning systems in chapter 3 (Figure 3.26).

Stage two was to empirically test the proposed model. Partial Least Squares-Structural Equation Modelling (PLS-SEM) technique was used to test the model. SmartPLS version 3.2.8 was utilized to conduct the analysis. The model was tested using data collected from students using Moodle LMS for the purposes of e-learning at the University of Warwick. 563 valid responses were received. Both quantitative and qualitative data were collected through an online and offline questionnaire, and one open-ended question at the end of the questionnaire. The study model was tested in three phases. *Phase one* was to test the measurement model (chapter 6, section 6.3.1) to examine the reliability and validity of each factor and indicator in the model for the evaluation of e-learning systems success. No significant change to the model occurred. Seven indicators were eliminated from the model. Indicator reliability was tested using indicator loading. Internal consistency reliability for each construct was tested using Cronbach's alpha (α), and composite reliability (CR). Validity of constructs was tested using convergent and discriminant validity. Convergent validity was tested using AVE. Discriminant validity was tested using three tests: Fornell-Larcker, Cross-loading, and HTMT. The overall results indicated satisfactory reliability and validity of the measures selected in the model.

Phase two involved testing the structural model to examine the significance of relationships among the constructs (chapter 6, section 6.3.2). Hypotheses were examined using path coefficients β. Bootstrapping was performed to determine the significance of the relationships. The bootstrapping procedure allows the *t* values and *p* values to be computed for all structural path coefficients. The statistical significance level used in this study was 5% following the majority of studies in information systems and e-learning domain. That is, p value < 0.05 and t value > 1.65 to accept the hypothesis.

The results obtained from phase two were employed to determine the potential relationships between factors of the model, as depicted in Figure 8.44 below.

Phase three analysed the qualitative data collected from students' comments. Thematic analysis was utilized to analyse the data. The results obtained from content analysis were in parallel and supporting the quantitative results. Based on the results obtained in Chapter 6 (section 6.3.3), the factors influencing the success of the e-learning system based on their relevance to students were technical system quality; information quality; satisfaction; educational system quality; use; usefulness; instructor quality; benefits; learner quality; service quality; and support quality respectively. The results confirm the validity and reliability of the selected measures to evaluate the success of the e-learning system and provided additional insight into the study results.

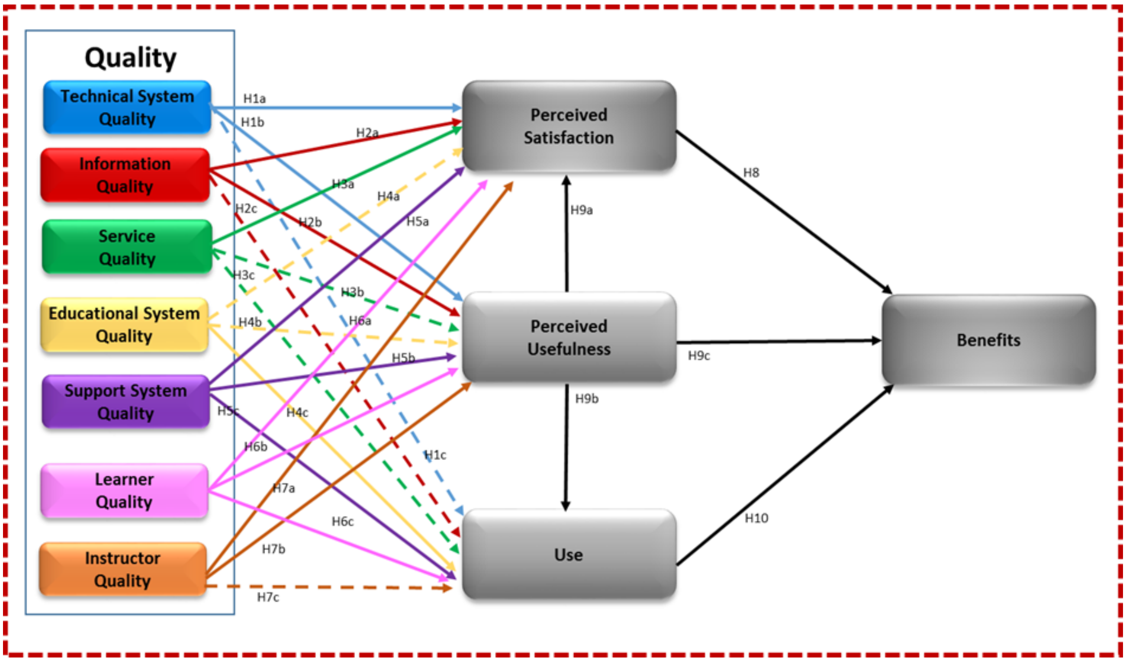


Figure 8.44: Model Hypotheses Results Summary

Finally, the results obtained from the three phases allowed us to answer RQ2 "What are the determinants of perceived satisfaction, perceived usefulness, use, and benefits of the e-learning system from students' perspective". The antecedents of perceived satisfaction, perceived usefulness, use, and benefits of the e-learning system are shown in Table 8.66.

Exogenous	Endogenous	Amount of variances explained
1. Technical System Quality 2. Information Quality 3. Service Quality 4. Learner Quality 5. Instructor Quality 6. Support System Quality 7. Perceived Usefulness	**PERCEIVED SATISFACTION**	**71.4%**
1. Technical System Quality 2. Information Quality 3. Learner Quality 4. Instructor Quality 5. Support System Quality	**PERCEIVED USEFULNESS**	**54.2%**
1. Educational System Quality 2. Support System Quality 3. Learner Quality 4. Perceived Usefulness	**SYSTEM USE**	**34.1%**
1. Perceived Satisfaction 2. Perceived Usefulness 3. System Use	**BENEFITS**	**65%**

Table 8.66: Determinants of SAT, USF USE, and BNT

The third research question "Is the model of the study valid and reliable for the evaluation of e-learning systems?" was addressed by the results obtained from testing both the measurement and structural models. The results obtained from the measurement model confirmed the validity and reliability of the selected indicators and constructs in the model. The majority of hypotheses gained empirical support (19 out of 26). The coefficient of determination R^2 has been employed as a criterion of predictive accuracy in the structural model assessment. The study model has substantially explained the variances of e-learning satisfaction (71.4%), moderately to substantially for benefits and perceived usefulness with the amounts of (65%, 54.2%) respectively, and moderately for the dependent variable system use with the amount of (34.1%). Compared with prior models, this study model is more capable of explaining the variances among the success dimensions of e-learning. The predictive relevance Q^2, which measures how well the observed values are reproduced by the path model, was also used. The results showed a strong predictive power among each of the following: perceived usefulness; perceived satisfaction; and benefits, and moderate predictive power for e-learning system use.

The whole model fit was assessed using Standardised Root Mean Square Residual (SRMR), Root Mean Square Residual (RMS_{theta}), and Goodness-of-Fit (GoF). The results show that criteria of model fit met the cut-off level and large goodness of fit value obtained (0.49). Thus, the model is valid, reliable, and applicable to evaluate the success of e-learning systems and this straightforwardly answers the third research question.

8.3 Research Contribution

The contribution of this research is multifaceted. This research provides theoretical as well as practical contributions.

8.3.1 Theoretical Implications

The first contribution of this study lies in its ability to develop a multi-dimensional, comprehensive model for evaluating the success of e-learning. The model was developed based on an intensive literature review and analysis of four approaches for measuring the success of e-learning as a theoretical basis: DeLone and McLean information systems success model (D&M model), Technology Acceptance Model (TAM); user satisfaction models; e-learning quality models. This new model is believed to be holistic because different perspectives have been considered in relation to quality, satisfaction, acceptance, social factors and benefits of using the e-learning systems, and these encompass the main components of the existing four approaches (Al-Fraihat et al., 2018).

Second, this study offers an empirical investigation of the model developed, incorporating the factors that influence the success of e-learning systems. In this study, seven types of quality factor, as antecedents of perceived satisfaction, perceived usefulness, use, and benefits, are proposed and empirically examined, namely: technical system quality, information quality, service quality, educational system quality, support system quality, learner quality, and instructor quality. Collectively, all these factors are valid and important measures and contribute to the identification of e-learning success factors and is the second contribution of this research.

Third, this research, compared to prior research, took a step forward in investigating the relationships between the aforementioned seven quality factors and each of perceived satisfaction, perceived usefulness, use, and benefits. This compared with previous research, where attention was given to just one of these, usually satisfaction. Additionally, the direct relationships between perceived satisfaction, system use, and perceived usefulness, with e-learning benefits on individuals, have rarely been examined in e-learning studies. Perez-Mira (2010) reported that “Individual impact per se is the most ambiguous to define”. The three aforementioned factors were employed to measure the influence of these on students’ benefits, and moderately to substantially explained 65% of its variance.

The current research also investigated new relationships which have not been empirically tested before (e.g., the relationship between learner quality, instructor quality, educational system quality and support system quality with system use, perceived usefulness). Prior studies referred to the relation with satisfaction only. As far as we know; however, this is one of the first studies to provide a comprehensive identification of e-learning success factors and to empirically examine the relationships between the measures in one single model, which is the third contribution of this study.

The fourth contribution revolves around the performance of the developed model. The model showed a strong predictive power among perceived usefulness, perceived satisfaction, and benefits, and moderate predictive power for use. The model has substantially explained 71.4% of the variation of e-learning perceived satisfaction, moderately to substantially explained the variance of benefits and perceived usefulness with the amounts of 65% and 54.2% respectively. It has moderately explained 34.1% of the variation of e-learning use, which compared to prior models considered a novelty.

Finally, the research presents important theoretical contributions in the information systems field and e-learning success theories. It contributes to the DeLone and McLean model literature, TAM, and e-learning satisfaction and success theories by proposing an extension of the original DeLone and McLean information systems success model. Additionally, this study confirms the validity of DeLone and McLean information systems success model for evaluating the success of e-learning systems in the context of the UK.

8.3.2 Practical Implications

Considering the fact that approximately 99% of higher education institutes use an LMS (i.e., Moodle, Blackboard, WebCT, Desire2Learn), and that there has been considerable investment in the use and delivery of these systems to support and facilitate learning process (Fathema et al., 2015), the study results have shed light on important issues and recommendations that should be taken into consideration to improve the perceptions of the satisfaction, usefulness, use, and benefits of e-learning systems. The study provides practitioners with several practical contributions, as follows.

1. This study provides universities and higher education institutes with a valid, reliable, comprehensive model and an instrument to evaluate the success of their learning management systems. In summary, the study model introduces 11 dimensions that consider the evaluation of e-learning in all phases, from the design phase, to system usage and user belief, to the outcome phase. This will greatly help those engaged in e-learning, in general, and LMS, in particular, to better understand how the use of the system can be increased and how perceptions of satisfaction, usefulness, and outcomes of the system can be improved.
2. Given that many universities start with a commercial or open source LMS, including the University of Warwick, the study results draw the attention of institutions to the need to improve the current learning management system (Moodle LMS). The study results reveal the crucial issues that students face, which indicate the unsuitability of the current system for target users, and consequently affect the successful delivery and effective use of the system, thereby hindering the usefulness and learners' satisfaction with the system. The main issues students face with Moodle are summarized as follows.
    - Difficulty in finding the required information, which confuses students and wastes their time in searching for the information;
    - Difficulty in navigation;
    - Poor, non-intuitive and non-attractive design;
    - Inconsistency of layout across the different modules;
    - Missing useful and helpful system features:
        - notifications;
        - search function;
        - personalized frequently-accessed section;
        - platform incompatibility with mobiles and other devices;

- providing lecture materials in a format that is accessible by most devices;
- integrated calculator to show the results ‘grades’ in all modules;

- ➢ Poor organization and structure of the content;
- ➢ Outdated content and information;
- ➢ System crashes;
- ➢ Lack of effective and interactive communication;
- ➢ Lack of timely, helpful instructors’ feedback to students’ questions and inquiries;
- ➢ Lack of training for instructors about the features provided and how to organize materials and content uploaded in the system;
- ➢ Lack of training and induction for students on how to use the system.

3. This study brings awareness to the University of Warwick in particular, and higher education institutes more generally, of the significant role the educational system quality plays in increasing the use of e-learning systems. The study reveals that the existence of communication and interactivity features, assessment and evaluation materials, and the diversity of learning styles, positively and significantly influence their utilization of the e-learning system, and help students to be more engaged in their learning (refer to H4c in section 7.3.4). Therefore, more effort should be directed toward effectively using these tools to the full capabilities in the e-learning systems.
4. This study draws the attention of the University of Warwick and higher education institutes of the potential role the instructors play in the success of e-learning. The study reveals that instructor quality has a significant effect on perceptions of satisfaction and usefulness of the system (refer to H7a and H7b in section 7.3.7). However, the majority of instructors do not take advantage of the full capabilities and advances available in the e-learning systems, which could potentially improve and facilitate students’ learning process. Pajo and Wallace (2007) have emphasized that the successful integration and implementation of technology in teaching, depend not only on the availability of technology, rather on the instructors embracing and using it. The qualitative data also revealed that instructors’ lack of knowledge and control over the technology negatively affected the performance of students and the overall usefulness of the system (as has been shown in section 7.4). As a result, proper and extensive training of instructors prior to using the e-learning system is vital. Moreover, periodic training programs should be offered to deliver any updates and have regular feedback. Additionally, the e-learning system should offer online help. This will help instructors to gain an in-depth understanding and confidence in using the e-learning system, in addition to increasing their awareness of the full features and usefulness of the system.

5. This study brings awareness to the University of Warwick and higher education institutes of the important role that service quality plays in the success of e-learning. Thus, the availability of knowledgeable IT personnel who have fair understanding of specific learners' needs, providing timely response to students, in addition to providing training and clear instructions to students on using the e-learning system is recommended to ensure the effective and smooth running of the system and the availability of service when needed for instructors, students, and faculty members. This will increase perceptions of satisfaction toward the e-learning system (refer to H3a in section 7.3.3).
6. Our results indicate that supportive issues in the e-learning system have a significant and positive influence on all of the following: system use, perceived usefulness, and perceived satisfaction of the e-learning system (refer to H5a, H5b, H5c in section 7.3.5). Considering the wealth of resources and information available on the Internet, these results indicate that faculty members and administrators should provide sufficient information to students regarding plagiarism rules and regulations when submitting assignments. This can be delivered by providing extra modules on this matter through the e-learning system. Furthermore, copyright issues, accessibility of content, permission for viewing the course materials, and intellectual property issues, all should be clearly delivered to students using the e-learning system.
7. The study revealed that the e-learning system used at the University of Warwick is incompatible with other platforms, such as mobile devices and other reading devices (refer to section 6.3.3.1 and section 7.4). E-learning designers and university policy makers should put more effort into designing the e-learning system to be compatible with most devices and fulfil the aim of e-learning which is learning anywhere and anytime.
8. The findings of this study bring the attention of the University of Warwick and other universities' top management to increasing the awareness among students about the usefulness and benefits of the e-learning system to increase its utilization and popularity (refer to H9a, H9b, and H9c in section 7.3.9). This can be achieved through delivering workshops and training to students. Therefore, learners' attitudes toward the e-learning system, learners' self-efficacy, and experience with the e-learning system are all increased, and students improve their skills and become more confident in using the e-learning system, thus increasing the perceptions of usefulness and satisfaction, and the usage of the e-learning system (refer to H6a, H6b, and H6c in section 7.3.6).
9. The study results can assist the University of Warwick and other institutions in recognizing that system characteristics such as, ease of using the system, reliability of the system, personalization, integration between system components, should be

improved to make the system more reliable, user-friendly, more personalized, attractive and more intuitive, and easier to navigate. These aspects should positively increase the perceived usefulness and satisfaction with the system (refer to H1a and H1b in section 7.3.1).

10. The study identifies issues with the quality of information that need to be addressed. This can assist the University of Warwick and other universities in concentrating considerable effort on providing students with sufficient, concise and clear information, which is well organized into logical and understandable components, in addition to regularly updating the content. In turn, this will increase the perceptions of usefulness and satisfaction of the system, thereby achieving the benefits of using the e-learning system (refer to H2a and H2b in section 7.3.2).
11. The study reveals that there is inconsistency in using the e-learning system among the university. Therefore, policy makers at the University of Warwick and other universities should make more effort to extend using the e-learning system across the departments and demonstrate that it is worth using. This can be achieved by increasing awareness, knowledge and familiarity of the e-learning system across faculties. It is also important to obtain more hands-on experience, and offer extensive training to improve faculty members' skills and self-efficacy, and offer supporting services, in addition to delivering awareness programs to inspire them to using the e-learning system to the fullest capabilities and benefit from the features available. Motivation and incentives for faculty members and instructors are also recommended. This, in turn, will increase learning outcomes, facilitate students' learning process, meet students' expectations, and positively increase system usage and perceptions about the usefulness and satisfaction toward the system (refer to H10 in section 7.3.10).
12. This study stresses that the University of Warwick and higher education institutes should periodically survey their students to collect feedback about their utilization and experience so far with the system, issues faced and obstacles, and any shortfalls or missing features that have to be addressed. This will ensure that the e-learning system is continuously reviewed and updated to cope with the technology evolving. Additionally, this will resolve any outstanding salient issues that students face. Hence, they can use the system more efficiently.

This research contributed to practice through the empirical study that undertaken to test the study model. Based on the results of the study, recommendations were proposed to the senior management of the University of Warwick.

8.4 Limitations and Recommendations for Future Studies

8.4.1 Limitations

Although respondents of the survey were students from different backgrounds, cultures and countries, attending one UK University, the validity and reliability of the model would improve if different universities within the UK were surveyed. In addition, this study was based on students' perceptions. Different groups of e-learning stakeholders (e.g., instructors, administrators) could enrich the research with different points of view and provide a better understanding of the issues facing e-learning systems success.

Also, the study model was tested using a single e-learning system, specifically the Moodle LMS. Consequently, results of the study may be restricted to this particular system. Further studies should investigate the validity of this model with different e-learning systems.

Furthermore, while the model extends the DeLone and McLean model, only the benefits for students (i.e., individual impacts) were measured in the study model. The organizational impacts which measure the net benefits at the organization level such as working results, and overall productivity improvements, remain a limitation for this model. Further research should investigate this construct.

Finally, the stability of the causal connections between the constructs of the model needs a longitudinal study to test if the connections will be consistent over specified time intervals, which was not feasible when conducting this research, and is considered a limitation.

8.4.2 Recommendations and Future Work

On account of the fact that e-learning success factors vary in terms of their relative significance, based on the context, we encourage different strategies to be adopted to deal with these factors. For example, in developing countries, obstacles are found in resources, accessibility and infrastructure, as well as the existence of communication features, and the important role of social factors (learner and instructor) receive more attention. In contrast, in developed countries, enhancing lifelong education, quality of information, usefulness of the system, and ethical and legal considerations are more outstanding (Bhuasiri et al., 2012; Mohammadi, 2015). Hence, further studies are recommended to examine the model in different contexts. Comparing the model in different contexts is also recommended.

Extending the model of DeLone and Mclean has explained 71.4%, 54.2%, 34.1%, and 65% of perceived satisfaction, perceived usefulness, use, and benefits respectively of e-learning success; however, it is not sufficient to fully capture the determinants of these factors. In other words, there is approximately 29% of the variance of e-learning perceived satisfaction, 46% of the variance of e-learning perceived usefulness, 66% of e-learning use, and 35% of e-learning benefits coming from other variables not examined in the model. Thus, there is still room to investigate the quality factors that determine the success of e-learning.

The (EESS) model proposed in this study with a considerable prediction and explanatory power, provides researchers with the basis for future research. Researchers can explain, justify, and compare the differences among the results. Researchers can also produce a shorter condensed instrument.

Finally, with technology and e-learning continuously evolving, longitudinal research to examine how the e-learning quality factors revealed in this study change over time may reveal additional interesting results.

8.5 Concluding Remarks

The dramatic growth and rapid expansion in adopting various kinds of e-learning systems in higher education institutes, together with the considerable investments in this field, has resulted in increasing the necessity to identify and understand the factors that influence the success of e-learning systems. Although several researchers on e-learning have investigated the success of e-learning systems, assessment of the success of e-learning systems has not received a holistic approach. This research aimed to investigate the factors that influence the success of e-learning systems in one comprehensive model and to empirically test the developed model.

The novelty of this research lies in its ability to develop a model which encompasses a collective set of measures associated with e-learning systems. The model has shown a considerable amount of predictive power and outperformed prior existing models in terms of the percentage of the explained variance among the dependent variables. The model substantially explains the variance of e-learning satisfaction, moderately to substantially explains both benefits and perceived usefulness, and moderately explains e-learning use. Empirical results have corroborated the reliability and validity of the constructs, the indicators and the whole model to evaluate e-learning systems success.

The model of the research contributes to the body of knowledge and theory in the e-learning field by providing a valid, reliable, and comprehensive model and instrument to evaluate the success of e-learning systems. Moreover, this study contributes to practice by shedding light on practical implications revealed from the study results to higher education institutes in general, and in particular, to the University of Warwick.

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APPENDICES

Appendix A: Invitation Email

Dear____________

I am Dimah Al-Fraihat, a postgraduate in the Computer Science Department. I am conducting my research titled:

Evaluation of E-learning Systems Success:
The Case of Moodle LMS at the University of Warwick

This study aims to develop a model that incorporates factors that influence the success of e-learning systems. As part of this study, we are conducting a survey to test the model of the study to increase our understanding of the factors that contribute to the success of e-learning systems and to examine the factors of the model.

I am writing to you to request your permission to disseminate an online questionnaire for your students enrolled in the online module_______________.

The purpose of the questionnaire is to evaluate the success of Moodle LMS and to determine the factors which influence the success of e-learning systems from students' opinion. The questionnaire generally focuses on Moodle at the University of Warwick through the various modules the students have been enrolled in.

Participation in this survey is voluntary. The questionnaire does not include any questions that require any personal identification related to the students or to the module being enrolled in. Participation in the survey will generate quantitative data which will be analysed in our research. The BSREC (Biomedical and Scientific Research Ethics Committee), University of Warwick has approved this survey and the reference number is REGO-2017-1917.

Your consent for sending the online questionnaire is highly appreciated and will be a valuable step in our research. If you are giving us the consent please reply to this email and state your preference whether to disseminate it in one of the classes running this term or online survey.

If you have any questions please do not hesitate to ask me Dimah Al-Fraihat (d.al-fraihat@warwick.ac.uk) or my supervisors Mike Joy (M.S.Joy@warwick.ac.uk) or Jane Sinclair (J.E.Sinclair@warwick.ac.uk).

A copy of the questionnaire is attached to this email.

Thanks!
Dimah Al-Fraihat

Postgraduate Student | Department of Computer Science | Educational Technology Lab | University of Warwick
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Appendix B: Questionnaire

Dear Student

I would like to invite you to participate in this students' survey, which is an important part of my PhD study: "Evaluating the Success of E-learning Systems – The Case of Moodle at the University of Warwick".

The purpose of this questionnaire is to evaluate the success of Moodle at Warwick and to determine the factors which influence the success of e-learning systems from your opinion. The questionnaire focuses on Moodle LMS at the University of Warwick through the various modules you have been enrolled in.

The questions are designed to enable quick and easy responses. Most of the questions can be answered simply by clicking the appropriate circle. Completing the questionnaire should take no more than 10 minutes.

Participation in this survey is voluntary. The questionnaire does not include any questions that require any personal identification. Please be assured that your responses will be treated as strictly confidential and you will not be individually identified in any reports of this data. The BSREC (Biomedical and Scientific Research Ethics Committee), University of Warwick has approved this survey and the reference number is REGO-2017-1917.

If you have any queries please do not hesitate to contact me (Dimah Al-Fraihat: d.al-fraihat@warwick.ac.uk).

Thank you for your participation and taking the time to respond.

Section 1: Demographic Information

Choose the appropriate answer:

1. **Gender:**
   - ○ Male
   - ○ Female
   - ○ Other

2. **Age**
   - ○ <21
   - ○ 21-30
   - ○ >31

3. **Enrolled Course:**
   - ○ Undergraduate
   - ○ Postgraduate

4. **Experience with Moodle:**
   - ○ Less than 1 year
   - ○ 1-2 years
   - ○ More than 2 years

5. **How many modules have you been enrolled in via Moodle?**
   - ○ One module
   - ○ More than one

6. **Field of Study:**
   - ○ Faculty of Medicine
   - ○ Faculty of Social Sciences (Economics, Law, Education, WBS … etc.)
   - ○ Faculty of Science and Engineering (Life Sciences, Chemistry, Biology, Physics, Mathematics, Engineering, WMG … etc.)

7. **I use Moodle to:** (select all that applies)
   - ○ Interact with my instructor and colleagues
   - ○ Access learning resources
   - ○ Accomplish and submit my assignments

Other ____________________________

Section 2: The Study Questions

Choose one answer for each question:

Measure		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Technical System Quality						
1.	It is easy to use Moodle					
2.	It is easy to understand the structure of Moodle and how to use it					
3.	Moodle meets my requirements and I can find the information I need					
4.	Moodle includes the necessary features and functions I need					
5.	Moodle is always available for me to perform learning activities					
6.	Moodle is flexible to interact with					
7.	All components within Moodle are fully integrated and consistent					

8.	Moodle launches and runs right away					
9.	Moodle does not crash frequently					
10.	Moodle protects my information from unauthorized access by logging only with my account and password					
11.	Moodle provides me with a personalised entry page (e.g., showing my modules, recommending additional modules and courses)					
Information Quality						
12.	Moodle has provided me with sufficient and required information					
13.	Information and resources needed from Moodle are always accessible					
14.	Information from Moodle is in a form that is readily usable					
15.	Information in Moodle is concise and clear					
16.	The structure of Moodle is well organized into logical and understandable components					
17.	The content of Moodle is up to date					
18.	I perceive the design of Moodle (e.g., fonts, style, colour, images, videos) to be good and meets the quality standards					
Service Quality						
19.	There are enough and clear instructions/training about how to use Moodle					
20.	Moodle provides a proper online assistance and help					
21.	The IT services staff is available and cooperative when facing an error at Moodle					
22.	The IT services staff understands the specific needs of students					
23.	I receive satisfactory and timely response from the IT services staff					
Educational System Quality						
24.	Moodle provides interactivity and communication facilities, such as, chat, forums, and announcements.					
25.	I believe that communication facilities have been effective learning components in my study					
26.	Moodle provides me with different learning styles (e.g., flash animation, video, audio, text, simulation, etc.) and they are interesting and appropriate in my study					
27.	Moodle provides evaluation components and assessment materials (e.g., quizzes; assignments)					
Support System Quality						
28.	Moodle provides appropriate information about plagiarism issues when submitting assignments through the system,					
29.	Moodle provides information about behavioural considerations when communicating with students or with instructors					
30.	Moodle provides information about accessibility of content, permission for viewing course materials, and any other personal data in the system					
31.	If it is optional, I would still prefer to use Moodle as a supportive tool in the module					

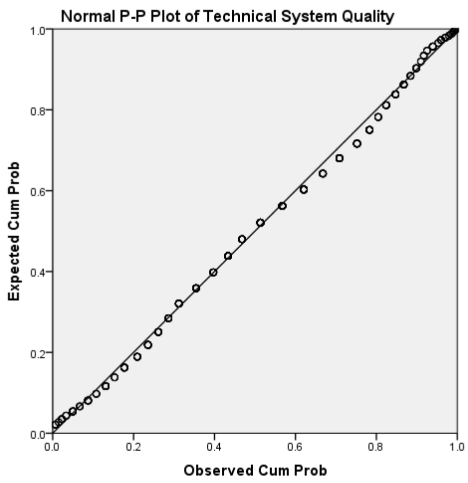
Learner Quality						
32.	I believe it is good to use Moodle					
33.	I have a positive attitude toward using Moodle					
34.	I am not intimidated by using Moodle					
35.	My previous experience with e-learning systems and computer applications helped me in using Moodle					
36.	I am able to perform tasks in Moodle successfully					
Instructor Quality						
37.	I use Moodle as recommended by my instructors					
38.	I think instructor's enthusiasm about using Moodle stimulates my desire to learn					
39.	I receive prompt response to questions and concerns from my instructors in Moodle					
40.	I think communicating and interacting with instructors are important and valuable in Moodle					
41.	Generally, my instructors have a positive attitude to utilization of Moodle					
Satisfaction						
42.	I am satisfied with the performance of Moodle					
43.	I enjoy using Moodle in my study					
44.	Moodle satisfies my educational needs					
45.	Overall, I am pleased with the experience of using Moodle					
Usefulness						
46.	Using Moodle enables me to accomplish my tasks more quickly					
47.	Using Moodle improves my learning performance					
48.	Using Moodle helps me learn effectively					
49.	Overall Moodle is useful					
Use						
50.	I use Moodle frequently					
51.	I depend on Moodle in my study					
52.	I use Moodle regularly					
53.	On average, I spend long time on using Moodle					
Benefits						
54.	Using Moodle has increased my knowledge and helped me to be successful in the module					
55.	Moodle is very effective education tool and has helped me to improve my learning process					
56.	Moodle makes communication easier with the instructor and other classmates					
57.	Moodle saves my time in searching for materials and cuts down expenditure such as paper cost					
58.	Moodle has helped me to achieve the learning goals of the module					

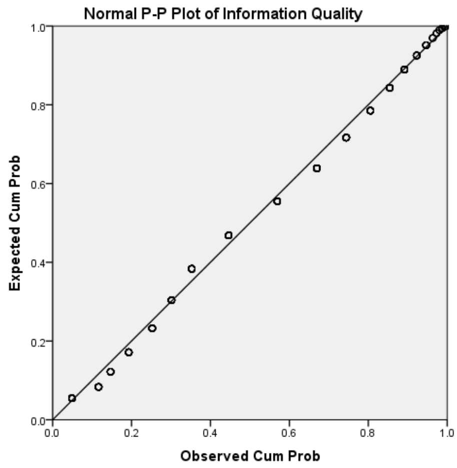
"Do you have any other comments related to Moodle?"

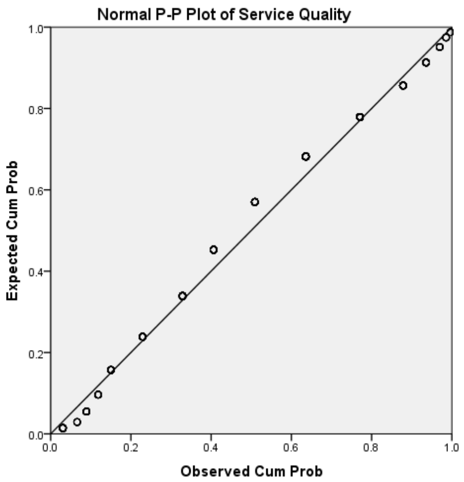
Appendix C: Normality of Data: Skewness and Kurtosis

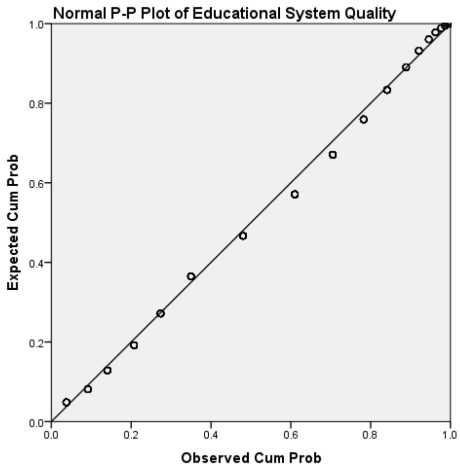
Items	Skewness	Kurtosis
TSQ1	2.264	-1.342
TSQ2	1.187	-1.140
TSQ3	-0.746	-0.050
TSQ4	0.604	-0.765
TSQ5	0.154	-0.678
TSQ6	-0.048	-0.707
TSQ7	0.310	-0.944
TSQ8	0.499	-0.766
TSQ9	0.919	-0.987
TSQ10	-0.369	-0.409
TSQ11	1.102	-1.109
INQ1	0.586	-0.586
INQ2	1.528	-1.127
INQ3	0.790	-0.794
INQ4	0.091	-0.514
INQ5	-0.535	-0.576
INQ6	-0.151	-0.685
INQ7	-0.565	-0.634
SRQ1	-0.932	-0.418
SRQ2	-0.312	0.242
SRQ3	-0.299	0.369
SRQ4	-0.451	0.210
SRQ5	0.410	0.394
ESQ1	-0.667	-0.429
ESQ2	0.157	-1.126
ESQ3	0.247	-0.997
ESQ4	0.041	-0.961
SUP1	-0.731	-0.072
SUP2	-0.496	0.049
SUP3	-0.880	0.163
SUP4	2.095	-1.238
LER1	1.392	-0.902
LER2	0.828	-0.908
LER3	0.523	-0.903
LER4	-0.467	-0.472
LER5	0.758	-0.688
INS1	1.854	-1.019
INS2	-0.571	-0.165
INS3	1.133	-1.038
INS4	0.705	-0.847
INS5	0.122	-0.568
SAT1	0.773	-0.519
SAT2	-0.007	-0.639
SAT3	1.565	-1.213
SAT4	1.406	-1.090
USF1	0.355	-0.801
USF2	-0.449	-0.443
USF3	0.034	-0.628
USF4	2.565	-1.151
USE1	3.123	-1.932
USE2	1.573	-1.476
USE3	2.468	-1.695
USE4	-0.432	-0.738
BNT1	0.316	-0.720
BNT2	-0.031	-0.646
BNT3	-0.441	-0.218
BNT4	0.244	-0.864
BNT5	0.377	-0.672

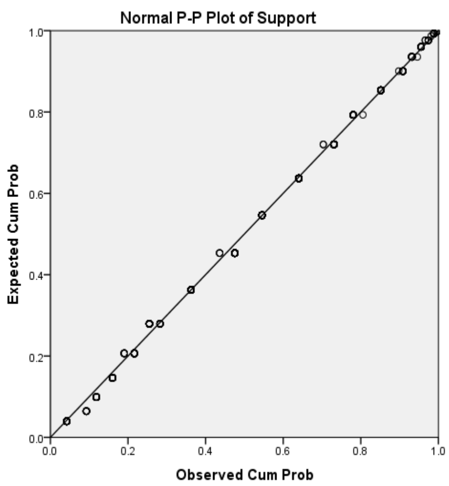
Appendix D: Multivariate Normality Test P-P plot

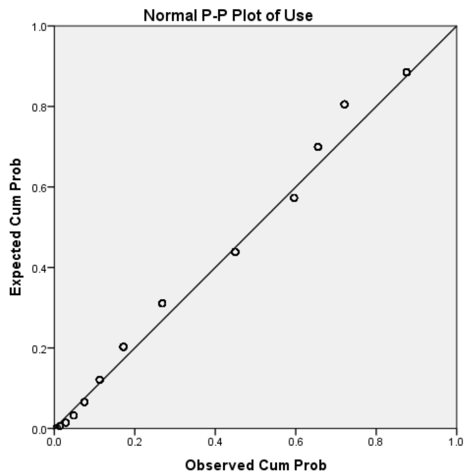


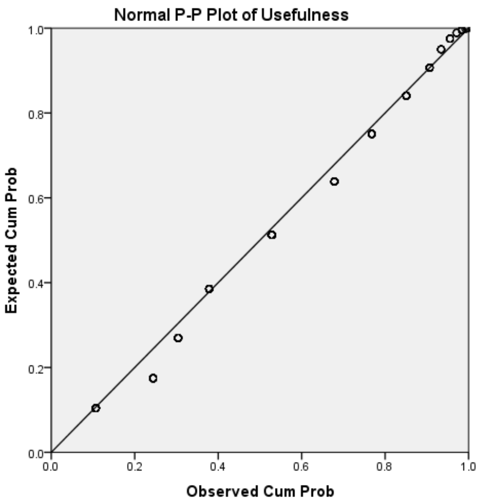


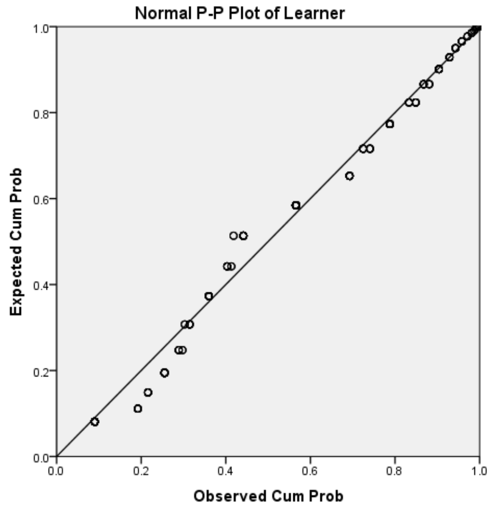


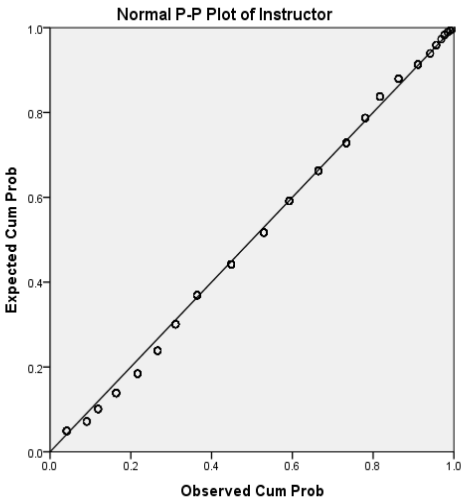


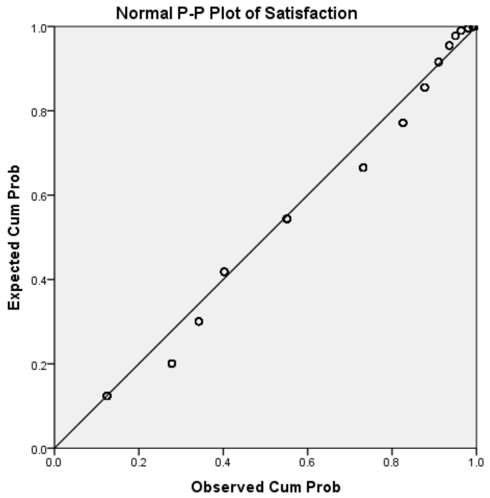


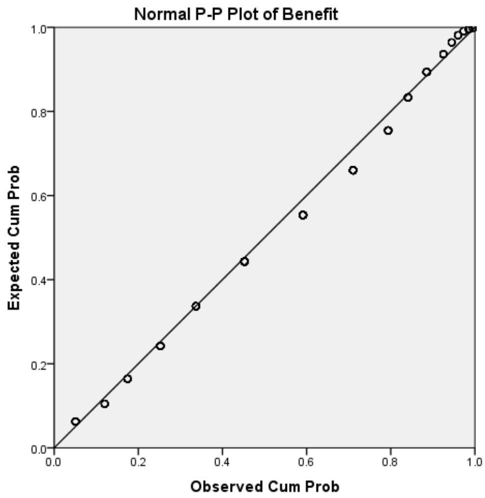


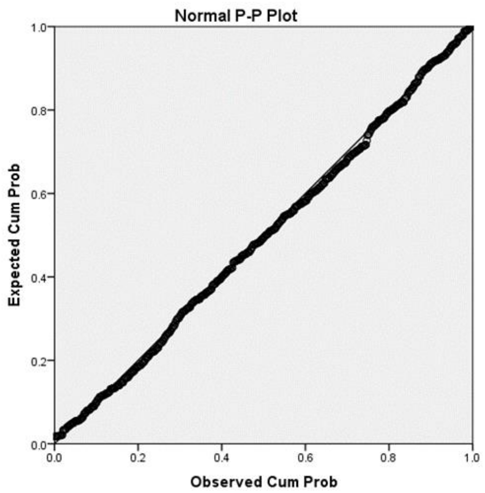












APPENDIX E: CROSS LOADINGS

	BNT	ESQ	INQ	INS	LER	SAT	SRQ	SUP	TSQ	USE	USF
BNT1	**0.840**	0.300	0.430	0.490	0.550	0.600	0.260	0.390	0.420	0.430	0.620
BNT2	**0.870**	0.330	0.570	0.510	0.670	0.710	0.330	0.420	0.520	0.440	0.690
BNT4	**0.770**	0.210	0.410	0.410	0.480	0.530	0.220	0.380	0.410	0.310	0.530
BNT5	**0.840**	0.300	0.450	0.460	0.570	0.600	0.240	0.450	0.460	0.410	0.650
ESQ1	0.320	**0.850**	0.330	0.300	0.300	0.330	0.180	0.370	0.300	0.270	0.320
ESQ2	0.120	**0.510**	0.130	0.250	0.130	0.120	-0.040	0.040	0.160	0.060	0.100
ESQ3	0.110	**0.550**	0.130	0.150	0.120	0.100	-0.030	0.070	0.100	0.130	0.070
ESQ4	0.320	**0.880**	0.350	0.330	0.290	0.290	0.140	0.360	0.280	0.300	0.270
INQ1	0.470	0.340	**0.730**	0.340	0.530	0.530	0.280	0.400	0.520	0.330	0.450
INQ2	0.390	0.220	**0.720**	0.280	0.460	0.450	0.280	0.310	0.490	0.210	0.390
INQ3	0.450	0.260	**0.820**	0.370	0.550	0.570	0.340	0.350	0.570	0.260	0.470
INQ4	0.480	0.270	**0.840**	0.360	0.580	0.570	0.360	0.340	0.630	0.250	0.500
INQ5	0.410	0.280	**0.780**	0.350	0.500	0.520	0.380	0.290	0.580	0.240	0.420
INQ6	0.320	0.270	**0.650**	0.320	0.370	0.420	0.290	0.240	0.490	0.170	0.360
INQ7	0.390	0.290	**0.650**	0.260	0.430	0.480	0.310	0.260	0.460	0.290	0.430
INS1	0.430	0.290	0.360	**0.630**	0.430	0.450	0.230	0.290	0.380	0.230	0.390
INS2	0.340	0.160	0.230	**0.690**	0.340	0.330	0.200	0.290	0.240	0.140	0.320
INS3	0.460	0.330	0.350	**0.840**	0.420	0.380	0.200	0.290	0.340	0.280	0.350
INS4	0.250	0.200	0.170	**0.570**	0.270	0.200	0.090	0.090	0.210	0.090	0.200
INS5	0.440	0.280	0.370	**0.780**	0.420	0.410	0.260	0.290	0.380	0.210	0.400
LER1	0.670	0.300	0.570	0.490	**0.880**	0.710	0.330	0.530	0.540	0.460	0.690
LER2	0.620	0.280	0.640	0.500	**0.890**	0.770	0.350	0.460	0.600	0.410	0.670
LER3	0.480	0.270	0.540	0.370	**0.800**	0.600	0.210	0.380	0.500	0.360	0.460
LER4	0.290	0.110	0.220	0.290	**0.460**	0.270	0.220	0.210	0.190	0.160	0.260
LER5	0.550	0.280	0.530	0.460	**0.820**	0.590	0.250	0.400	0.490	0.360	0.510
SAT1	0.570	0.280	0.540	0.400	0.630	**0.820**	0.340	0.430	0.460	0.370	0.550
SAT2	0.650	0.280	0.610	0.490	0.690	**0.890**	0.390	0.410	0.560	0.400	0.640
SAT3	0.670	0.310	0.600	0.460	0.670	**0.880**	0.380	0.440	0.570	0.460	0.660
SAT4	0.680	0.300	0.650	0.480	0.750	**0.920**	0.350	0.430	0.600	0.370	0.680
SRQ1	0.250	0.090	0.340	0.220	0.290	0.330	**0.760**	0.300	0.280	0.150	0.280
SRQ2	0.290	0.120	0.360	0.190	0.280	0.340	**0.810**	0.280	0.350	0.140	0.290
SRQ3	0.300	0.110	0.380	0.250	0.320	0.360	**0.900**	0.270	0.380	0.120	0.280
SRQ4	0.220	0.110	0.330	0.270	0.250	0.330	**0.800**	0.210	0.330	0.100	0.230
SRQ5	0.200	0.140	0.310	0.220	0.240	0.270	**0.680**	0.170	0.270	0.080	0.170
SUP1	0.250	0.280	0.200	0.240	0.250	0.190	0.160	**0.700**	0.140	0.180	0.220
SUP2	0.280	0.210	0.210	0.230	0.240	0.230	0.260	**0.750**	0.200	0.130	0.230
SUP3	0.330	0.230	0.260	0.260	0.300	0.280	0.300	**0.790**	0.210	0.160	0.300
SUP4	0.500	0.340	0.450	0.340	0.570	0.550	0.240	**0.800**	0.390	0.430	0.570
TSQ1	0.510	0.240	0.550	0.370	0.590	0.560	0.260	0.330	**0.800**	0.360	0.500
TSQ3	0.420	0.290	0.570	0.330	0.490	0.450	0.270	0.240	**0.800**	0.290	0.390
TSQ4	0.430	0.200	0.570	0.390	0.460	0.450	0.300	0.260	**0.770**	0.240	0.420
TSQ6	0.370	0.290	0.540	0.340	0.420	0.470	0.380	0.280	**0.750**	0.190	0.360
TSQ7	0.330	0.230	0.540	0.300	0.390	0.450	0.380	0.270	**0.700**	0.130	0.370
USE1	0.400	0.320	0.330	0.240	0.420	0.410	0.150	0.330	0.300	**0.890**	0.460
USE2	0.450	0.260	0.330	0.240	0.440	0.440	0.140	0.310	0.310	**0.920**	0.540
USE3	0.430	0.280	0.300	0.220	0.420	0.400	0.120	0.300	0.290	**0.930**	0.490
USE4	0.430	0.230	0.250	0.320	0.370	0.370	0.140	0.330	0.260	**0.800**	0.460
USF1	0.640	0.280	0.500	0.410	0.570	0.640	0.330	0.480	0.490	0.470	**0.850**
USF2	0.680	0.270	0.470	0.420	0.580	0.620	0.270	0.440	0.430	0.500	**0.910**
USF3	0.680	0.260	0.480	0.440	0.570	0.600	0.280	0.440	0.450	0.470	**0.900**
USF4	0.640	0.290	0.590	0.440	0.680	0.670	0.250	0.430	0.520	0.470	**0.830**