A MODEL FOR E-LEARNING SYSTEMS QUALITY ASSESSMENT WITH EMPHASIS IN PAKISTAN

SHAHID FARID

FACULTY OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY
UNIVERSITY OF MALAYA
KUALA LUMPUR

2016

A MODEL FOR E-LEARNING SYSTEMS QUALITY ASSESSMENT WITH EMPHASIS IN PAKISTAN

SHAHID FARID

THESIS SUBMITTED IN FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

FACULTY OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY
UNIVERSITY OF MALAYA
KUALA LUMPUR

2016

UNIVERSITY OF MALAYA

ORIGINAL LITERARY WORK DECLARATION

Name of Candidate: Shahid Farid

Registration/Matric No: WHA120017

Name of Degree: Doctor of Philosophy (Ph.D.)

Title of Project Paper/Research Report/Dissertation/Thesis ("this Work"):

A Model for E-learning Systems Quality Assessment with Emphasis in Pakistan

Field of Study: Software Quality (Computer Science)

I do solemnly and sincerely declare that:

(1) I am the sole author/writer of this Work;
(2) This Work is original;
(3) Any use of any work in which copyright exists was done by way of fair dealing and for permitted purposes and any excerpt or extract from, or reference to or reproduction of any copyright work has been disclosed expressly and sufficiently and the title of the Work and its authorship have been acknowledged in this Work;
(4) I do not have any actual knowledge nor do I ought reasonably to know that the making of this work constitutes an infringement of any copyright work;
(5) I hereby assign all and every rights in the copyright to this Work to the University of Malaya ("UM"), who henceforth shall be owner of the copyright in this Work and that any reproduction or use in any form or by any means whatsoever is prohibited without the written consent of UM having been first had and obtained;
(6) I am fully aware that if in the course of making this Work I have infringed any copyright whether intentionally or otherwise, I may be subject to legal action or any other action as may be determined by UM.

Candidate's Signature Date: 01.08.2016

Subscribed and solemnly declared before,

Witness's Signature Date: 01.08.2016

Name: Dr. Rodina Binti Ahmad

Designation: Associate Professor

ABSTRACT

E-learning systems have been implemented widely in Higher Education Institutions (HEIs) round the globe. The poor quality of e-learning systems is one of the major causes of number of reported failures. Researchers have proposed quality models of the e-learning systems but most of them have focused on pedagogical perspective only. A very limited attention is given to assess the quality of e-learning systems from software perspective. Hence, it is quite difficult to measure the overall quality of an e-learning system in an effective manner. In this study, a pragmatic mixed mode methodology has been adopted to overcome the challenge of the quality assessment of e-learning systems. An exploratory study has been conducted to identify and prioritize the critical challenges of e-learning implementation according to their criticality and importance. Systematic Literature Review (SLR) has been conducted to probe the research focus formulated in our exploratory study. An exhaustive list of forty-two quality characteristics which make the foundation for the proposition of a Sustainable Quality Assessment Model for E-Learning Systems (SQAMELS) has been developed. Moreover, process guidelines for the utilization of the SQAMELS have also been formulated. The SQAMELS encompasses of three major dimensions namely system quality, service quality and charisma. The proposed solution contributes in a fashion to be utilized by the HEIs of developing countries like Pakistan for the quality assessment of their e-learning systems. Moreover, this study facilitates the researchers and academicians by providing recommendations for future research regarding the assessment and evaluation of the quality of the e-learning systems. The developed model and the approach has been evaluated by a) comparative analysis of features with existing e-learning quality

models and frameworks, b) survey analysis by practitioners to measure the applicability c) experts review to gauge its usefulness and d) conducting a case study to assess the applicability and utility of the proposed model. The results showed that there is no significant difference amongst the experts and practitioners at the 95% confidence level. This indicates that the SQAMELS is applicable and useful for the quality assessment of the e-learning system for the HEIs of developing countries such as Pakistan.

ABSTRAK

Sistem E-pembelajaran telah dilaksanakan secara meluas di Institusi Pengajian Tinggi (IPT) pusingan dunia. Kualiti miskin sistem e-pembelajaran adalah salah satu punca utama bilangan kegagalan dilaporkan. Para penyelidik telah mencadangkan model kualiti sistem e-pembelajaran tetapi kebanyakan mereka telah memberi tumpuan kepada perspektif pedagogi sahaja. Perhatian yang sangat terhad diberikan untuk menilai kualiti sistem e-pembelajaran dari perspektif perisian. Tambahan pula, arena e-pembelajaran tidak mempunyai mekanisme kualiti penilaian yang jelas. Oleh itu, adalah agak sukar untuk mengukur keseluruhan kualiti sistem e-pembelajaran dengan cara yang berkesan. Dalam kajian ini pragmatik metodologi mod campuran telah diterima pakai bagi kajian ini untuk mengatasi cabaran bagi penilaian kuality sistem e-pembelajaran. Satu kajian penerokaan telah dijalankan untuk mengenal pasti dan mengutamakan cabaran kritikal pelaksanaan e-pembelajaran mengikut kritikal dan kepentingan. Kajian Sistematik Literatur (KSL) telah dijalankan untuk menyiasat tumpuan penyelidikan dirumuskan dalam kajian penerokaan kami. Senarai lengkap empat puluh dua (42) ciri-ciri kualiti yang menjadikan asas bagi cadangan daripada novel Penilaian Kualiti Rangka Kerja bagi Sistem E-pembelajaran (PKRKSEP) telah dibangunkan. The PKRKSEP merangkumi tiga dimensi utama iaitu kualiti sistem, kualiti perkhidmatan dan karisma. Penyelesaian yang dicadangkan menyumbang dengan cara yang akan digunakan oleh IPT dari Pakistan untuk kualiti penilaian sistem e-pembelajaran mereka. Selain itu, kajian ini akan memudahkan para penyelidik dan ahli akademik dengan menyediakan cadangan-cadangan untuk kajian akan datang mengenai penilaian dan kualiti penilaian sistem e-pembelajaran. Rangka kerja yang

dibangunkan telah dinilai oleh a) analisis perbandingan ciri-ciri dengan kualiti model dan rangka kerja e-pembelajaran sedia ada, b) Kajian analisis yang dijalankan oleh pengamal untuk mengukur kesesuaian c) pakar kajian untuk menilai kegunaan rangka kerja yang dicadangkan dan d) menjalankan kajian kes untuk menilai kesesuaian dan utiliti model yang dicadangkan. Hasil kajian menunjukkan bahawa terdapat perbezaan yang signifikan di kalangan pakar-pakar dan pengamal pada tahap keyakinan 95%. Ini menunjukkan bahawa PKRKSEP adalah mudah untuk memohon dan berguna untuk kualiti penilaian sistem e-pembelajaran pada alam sekitar setempat daripada IPT Pakistan.

ACKNOWLEDGEMENTS

I desire to express my special gratitude to my parents, as without their prayers and support, it was not possible for me to be at this stage of my life. Besides, I may thank my wife, Tahira Parveen, for her family support during all stages of this research. She played a vital role in maintaining my physical and mental health especially during my stay in Malaysia. Besides these I cannot forget my loving children Abdullah, Eesha and Abdul Rehman.

I extend my heartiest gratitude to my supervisor Assoc. Prof. Dr. Rodina Binti Ahmad, Head, Department of Software Engineering, University of Malaya, Kuala Lumpur, Malaysia, whose guidance always remained a source of inspiration towards completion of this research work. She always took pain to complete this research. I cannot ignore many of her productive discussions despite her tight and busy schedule of work.

Last, but not least, this dissertation was not possible without the kind and unconditional support of my teachers and friends such as Dr. Mujahid Alam (ICCC), Dr. Iftikhar Azim Niaz (COMSATS), Dr. Daud Khattak (AIOU), Dr. Atif Akbar (BZU). I would also like to thank Bahauddin Zakariya University, Multan, Pakistan for facilitating me with the study leave and administrative support that is most valuable for international doctoral students. All this support has allowed me to concentrate efforts on my research.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS AND ABBREVIATIONS

AHP	:	Analytical Hierarchal Process
AIOU	:	Allama Iqbal Open University
ANOM	:	Analysis of Means
CAI	:	Computer Assisted Instruction
CBT	:	Computer Based Training
CID	:	Centre of Instructional Design
CMS	:	Content Management System
Df	:	Degree of Freedom
HEC	:	Higher Education Commission
HEIs	:	Higher Education Institutions
HELAM	:	Hexagonal E-Learning Assessment Model
ICT	:	Information and Communication Technology
ID	:	Instructional Design
IS	:	Information System
IT	:	Information Technology
KMS	:	Knowledge Management System
KPK	:	Khyber Pakhtunkhwa
LMS	:	Learning Management System
LO	:	Learning Object
MLO	:	Mobile Learning Object
OLIVE	:	Online Learning Institute of Virtual Education
PCA	:	Principal Component Analysis
PTA	:	Pakistan Telecommunication Authority

R&D	:	Research and Development
RUP	:	Rational Unified Process
SD	:	Standard Deviation
SDLC	:	Software Development Life Cycle
SLR	:	Systematic Literature Review
SQAMELS	:	Sustainable Quality Assessment Model for E-Learning Systems
TICS	:	Technology, Interaction, Content, Services
VLE	:	Virtual Learning Environment
VU	:	Virtual University
WWW	:	World Wide Web

CHAPTER 1: INTRODUCTION

Online learning or sometimes called electronic learning (e-learning) is one of the tools which emerged from the internet usage. It is considered as a modern form of learning in which teaching-learning method is assumed to be self-directed. E-learning is any type of learning that is executed using electronic mode of communication, based on communication technology. E-learning applications and processes may be one of the web-based learning, computer-based learning, virtual learning opportunities and digital collaboration (Abdellatief, 2011). It is actually collaborative and self-directed learning based on web technologies (Bleimann, 2004). Sun et al. (2008) urge that e-learning is the use of telecommunication technology to deliver information for education and training. Furthermore, e-learning can be defined as a learning platform or learning environment (sometimes also called an e-learning tool) based on internet, which encourages the learners and instructors to cooperate with each other to enhance learning (Hassanzadeh, Kanaani, & Elahi, 2012; Lau, Yen, Li, & Wah, 2013). E-learning platforms or environments can be recognized as Learning Management System (LMS), Content Management System (CMS), Virtual Learning Environment (VLE), sometimes also called a Knowledge Management System (KMS) and content authoring tools (Babu, 2005; J. L. Moore, Dickson-Deane, & Galyen, 2011; Wilen-Daugenti, 2009). In this study, we will use the synonym "e-learning" to refer as web-based learning systems and "e-product" to refer as a software tool, platform or environment for e-learning system.

E-learning is a rapidly progressive method of education and training due to its ease of accessibility, learning, training, cost effectiveness, flexibility, portability and better content delivery to the learners round the globe (Anuwar & Datuk, 2004;

Bhuasiri, Xaymoungkhoun, Zo, Rho, & Ciganek, 2012). E-learning has been generating a lot of new opportunities in education by extending the potential to reach to the new learners to deliver education. With the rapid increase in the usage of Information and Communication Technologies (ICT), many universities around the world are switching to this mode of learning in order to attract more and more learners from the remote areas. In the steady evolution of the adoption of e-learning, quality has become very important for the Higher Education Institutions (HEIs) involved in e-learning. Several questions has been raised about the quality of the e-learning systems e.g. how to measure the quality of the e-learning system? What are the important attributes for measuring the quality of the e-learning systems? What are the crucial factors for the quality assurance of e-learning systems?

1.1 Need of the Study

Many countries are integrating ICT in education to enhance the learner's experience of learning (Pagram & Pagram, 2006). The widespread use of ICT in the education sector of the developed countries has led to the establishment of completely ICT-based universities called virtual universities. On the other hand, e-learning is still in its early stage of adoption and implementation in most of the developing countries. Many developing countries including Pakistan are eager to implement e-learning (Grönlund & Islam, 2010). This drift of adoption and implementation of e-learning can easily be perceived in the developing countries like Pakistan. There is rapid growth of ICT infrastructure in Pakistan since year 2000. In Pakistan, e-learning is not gaining as much attention as it was earlier predicted (A. Khan, 2007) since it is experiencing various challenges which are quite different from developed countries. These challenges include lack of implementation process,

quality assurance of e-learning system, development of localized learning objects, ICT infrastructure, internet access, resources, institutional support, personal characteristics, socio-economic situation, power failure as well as policies and cultural constraints (Bhuasiri et al., 2012; Farid, Ahmad, Niaz, et al., 2015; A. Khan, 2007; Nawaz, 2012).

More than 1000 institutions in 50 countries have shifted towards this new learning paradigm (Bhuasiri et al., 2012) as mode of education and training with the growth rate of 35.6% in the arena of e-learning. There are indications of successful implementation of e-learning systems but failures do exist (Masoumi & Lindström, 2012; Sun, Tsai, Finger, Chen, & Yeh, 2008). One of the main reasons of the failures is the low quality of the e-learning systems. Moreover, the usability of most of the e-learning systems is not of high quality (Sun et al., 2008). We believe that if this convenient system of learning is established well it may become highly adaptable and consequently enhance the learning process. Hence, it is important to assure the quality of the e-learning systems.

Quality is difficult to measure hence it is crucial for a software system to be viable. Moreover, the quality of an e-learning system is twofold in nature: 1) pedagogical and 2) software. According to Ehlers in (Ehlers, 2004) it is the quality that defines the future of e-learning. It is urged by (Pawlowski, 2003) that quality in the area of e-learning is not associated with a well-defined measure. Hence, there is variation in theory and practice of evaluation or assessment of the quality of an e-learning system (Abdellatief, 2011; Baruque et al., 2007; Caramihai & Severin, 2009; Chua & Dyson, 2004; Kundi, Nawaz, & Khan, 2010; Ozkan & Koseler, 2009; Yunus & Salim, 2008).

There are only few evidences available in the literature about the efforts to assure the quality of the e-learning systems (McGorry, 2003; Moussa & Moussa, 2009). Moreover formal frameworks do not exist for assuring the quality of the e-learning systems. Therefore developing a quality assurance framework is the need of the hour, since the e-learning managers need a mechanism for assuring the quality of the e-learning tools such as LMS, CMS, KMS, VLE etc. (Babu, 2005). A very limited attention is given to the assessment and evaluation of the quality of e-learning tools (Padayachee et al., 2010) in spite of the importance of quality and its effect on user satisfaction. It can be safely concluded from the above discussion that the quality of an e-learning system is important and still remains an open question to be addressed and solved.

1.2 Problem Statement

The existing quality models are not adequate enough to be used for evaluation of the quality of an e-learning system. This arena lacks a well-defined quality assurance measure. A majority of the proposed quality models have focused on pedagogical aspects (including learner, instructor, institution, social, management etc.) ignoring the software perspective of e-learning system. However, some models and frameworks have addressed a limited number of quality characteristics (like usability, efficiency, portability, reliability etc.) of software perspective of the e-learning systems. However the quality of an e-learning system (software perspective) cannot be gauged using such a limited number of quality characteristics, unless other quality characteristics are taken into account. These quality characteristics may include availability of the e-learning system, ability to use on different devices (smart phones, tablets, laptops or desktops) independent of operating system and

specifications, flexibility, accessibility, reliability, efficiency etc. Additionally, the state-of-the-art quality models are inadequate to address the future needs of institutions explicitly. We need to have a new e-learning quality model that will explicitly identify and address those specific characteristics, which are particular for the e-learning domain. Hence, further efforts can be made by considering the future needs of the institutions.

Furthermore there is no agreement on the standard framework for the assurance of quality of the e-learning systems (Chua & Dyson, 2004). Therefore, there is still an open issue about the assessment and evaluation of the quality of e-learning systems.

1.3 Research Objectives

The fundamental goal of this research effort is to identify the challenges and problems faced by the HEIs of a developing country like Pakistan in adopting a quality e-learning environment and to propose a sustainable quality framework for assessing the quality of the e-learning systems. This will help the HEIs in assessing the quality of the e-learning system in order to improve its practice. The following objectives have been formulated for achievement of this goal;

1. To identify the current issues, challenges and their impact on the adoption and implementation of e-learning in developing countries like Pakistan.

   RQ1.1: What are the state-of-the-art issues, challenges or problems for the adoption and promotion of e-learning in HEIs?

RQ1.2: What is the impact of identified challenges on the adoption and promotion of e-learning?

RQ1.3: Which challenges are most crucial for the promotion of e-learning?

2. To critically analyze the existing quality frameworks and models of e-learning systems.

RQ2.1: What are the state-of-the-art quality standards (models or frameworks) for the e-learning systems?

RQ2.2: What are the perspective(s) and dimension(s) for the e-learning quality models and frameworks?

3. To identify main characteristics and sub-characteristics of e-learning quality from the existing literature.

RQ3.1: What are the quality goals (characteristics) which have been established by the existing quality models of e-learning system?

4. To propose a sustainable model for the quality assessment of e-learning systems for HEIs of developing countries.

RQ4.1: Which quality characteristics are crucial for the quality assessment of e-learning systems in the context of HEIs?

RQ4.2: What is the impact of proposed quality characteristics on the overall quality of e-learning systems?

5. To validate the proposed model.

1.4 Research Scope

E-learning systems are very broad and consist of various perspectives including pedagogical, personal, institutional, software and technical. The scope of this study covers the quality assessment of e-learning systems from the software perspective only in the HEIs of developing countries. Therefore, this study is not addressing other perspectives of the e-learning systems.

1.5 Research Methodology

This research adopts the pragmatic approach that provides an underlying philosophical framework for a mixed method research. The mixed method approach is widely used in domains such as behavioral, social, health and applied sciences (Castro, Kellison, Boyd, & Kopak, 2010; Creswell, Klassen, Plano Clark, & Smith, 2011). This mode of research method has the potential of providing a bridge between qualitative and quantitative methods (Castro et al., 2010). Moreover, it enhances the credibility of the research work by making it more acceptable to broader audiences. The blended approach provides a better understanding of the research problems rather than the simple qualitative or quantitative approaches (Clark, Huddleston-Casas, Churchill, Green, & Garrett, 2008; Yoshikawa, Weisner, Kalil, & Way, 2008). This research methodology comprises of five main phases as illustrated in Figure 1.1. The activities of the each phase are summarized as follows:

Phase 1: Identification of the Problem

First of all, a literature review of the existing research studies on the issues and challenges of e-learning was performed. Next, an exploratory study was conducted in the HEIs of Pakistan for the following purposes;

- To get a deeper insight and understanding of the e-learning scenario and/or problem being faced by HEIs.
- To investigate the diverse range of e-learning challenges.
- To identify the impact of challenges on the adoption and promotion of e-learning in the country.
- To rank the challenges according to their severity for the HEIs.

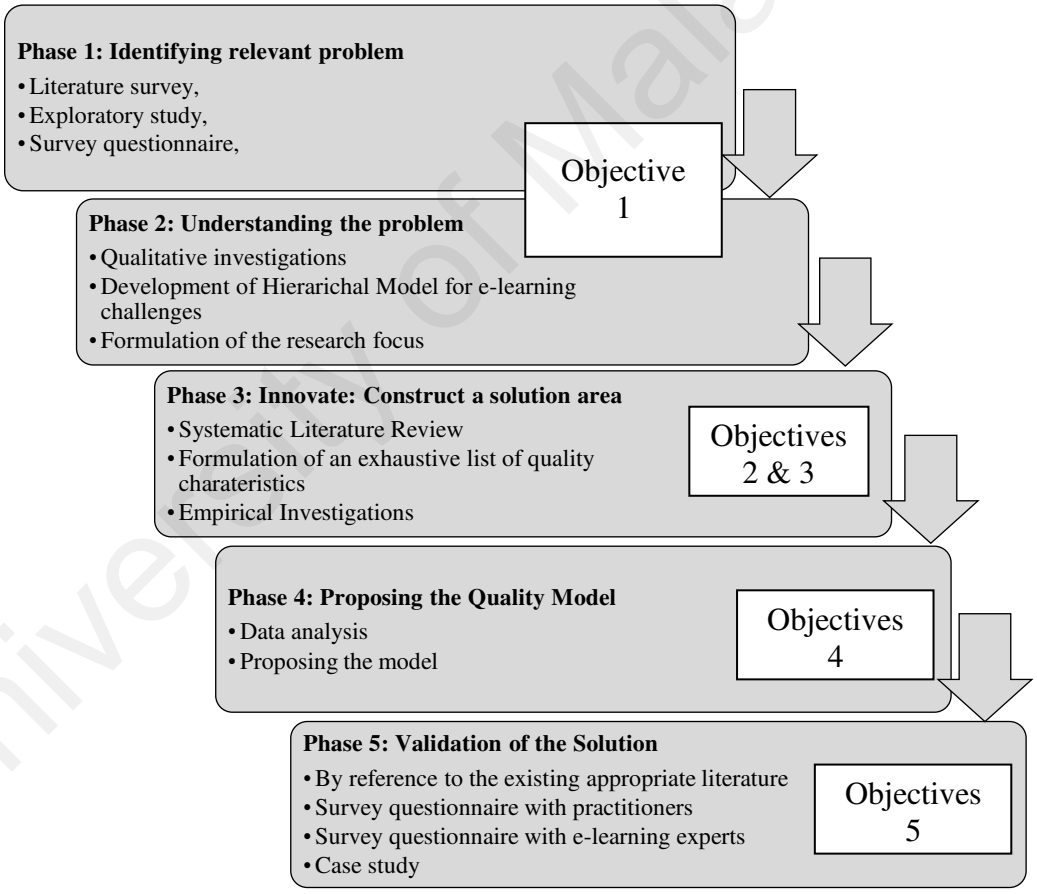


Figure 1.1: Research methodology mapped with research objectives

Phase 2: Understanding the Problem

In order to verify e-learning challenges or problems (identified in phase 1 of the research methodology) and to formulate the research focus that contributes in addressing one of the main e-learning challenge or problem, empirical investigations were carried out amongst e-learning experts. Moreover, these the targeted e-learning experts also helped in the identification of any missing challenge which could be crucial for the localized e-learning environment. Several challenges were highlighted by the experts during these investigations. These challenges were specific to the HEIs of Pakistan. Based on the discussions with e-learning experts and prioritizations of the identified challenges, one practical problem has been taken as research focus for this study. The findings from Phase1 and Phase 2 were intended to achieve objective 1.

Phase 3: Innovate: Construct a Solution Area

Another literature review, i.e. Systematic Literature Review (SLR) was performed in order to identify and analyze the existing e-learning quality models and frameworks. Quality characteristics of e-learning systems were recognized and collected through studying quality models and frameworks proposed for the quality assurance or assessment or evaluation of e-learning systems. As a result of the SLR and literature review, an exhaustive list of quality characteristics covering most of the perspectives of e-learning systems has been formulated. In order to provide the solution for the focused issues, another empirical study was conducted with e-learning experts in HEIs of Pakistan. These experts had been requested to sort out this exhausted list of quality characteristics by selecting the best suited factors

according to the requirements of HEIs of Pakistan. Activities performed during this phase were intended to fulfill the objective 2 and 3.

Phase 4: Proposing the Quality Model

A Sustainable Quality Assessment Model for the E-Learning Systems (SQAMELS) was developed on the basis of the empirical study conducted with e-learning experts of HEIs of Pakistan. Different statistical models like Principal Component Analysis, Logistic Regression, Kappa Analysis and Chi-Square were utilized which leaded this study to the final selection of quality characteristics for the proposed model. Activities during this phase were intended to achieve the objective 4.

Phase 5: Validation of the Model

In the final stage of the study, four types of validation methods were adopted to validate the proposed model. These methods include;

a) Review of Literature

The proposed model is validated by reference to the appropriate research literature. Existing literature provides a strong foundation for the validation of the suitability of the proposed model. Quality features addressed by existing e-learning quality models and frameworks are compared with the proposed model of this research.

b) Survey with Practitioners (Applicability Validation)

Empirical investigations are carried out to assess the appropriateness of the proposed model. Targeted population for this validation process is practitioners including software engineers, instructional designers, manages and directors of ICT/IT from industry and from HEIs indulge in e-learning.

c) Survey with Experts (Utility Validation)

A panel of experts consisted of academicians and researchers working in e-learning arena were the targeted population for this validation process. The objective was to validate the usefulness of the proposed model from e-learning experts by providing feedback in the form of survey questionnaire.

d) Case Study

A case study was conducted by applying SQAMELS on an existing e-learning system. The aim of conducting the case study was to validate the SQAMELS by gauging the usefulness, ease of use, applicability and adoptability in real environment. This case study was done on the LMS of one of the HEIs of Pakistan.

The activities performed to validate the proposed model have led this study to accomplish the objective 5. Mapping of the activities with research objective is already summarized in Figure 1.1.

1.6 Research Contribution

The aim of this dissertation is to attract different stakeholders of e-learning system by providing a roadmap to assure the quality of their e-learning systems in developing countries in general and Pakistan in particular. As there is no specific definition of quality of e-learning system, therefore the HEIs assure and evaluate quality of their adopted e-learning system in their own way. It is hoped that this work can harmonize different stakeholders on a quality framework up to satisfactory level. Our contribution includes;

1. The proposed model which can be used by HEIs of the developing countries in order to assess the quality of the e-learning system they are using or intend to adopt.
2. Identification of critical challenges of e-learning are categorized and presented in hierarchical model defining the priority of each challenge. This hierarchical model would help government agencies and the policy makers dealing with higher education, in revisiting their policies for the adoption and promotion of e-learning in Pakistan.
3. Formulation of an exhaustive list of quality characteristics for the e-learning systems.
4. Development of guidelines in order to utilize the proposed model.

1.7 Significance of Research

This research has significant implications for HEIs in assuring quality of their e-learning systems. Allama Iqbal Open University (AIOU) and Virtual University (VU) of Pakistan, and other HEIs in the country engaged in e-learning or planning to

practice it may benefit from this lifelong learning model presented through this research while adopting the e-learning system. In addition, virtual and open universities of the developing countries may also benefit from this research.

1.8 Outline of the Thesis

Chapter 1 presents the introduction to the research topic and provides an overview of the dissertation including research problem, research objectives, research methodology, research contribution and significance of the research. **Chapter 2** gives the review of the existing literature by highlighting the concept of e-learning, modes of e-learning and the challenges being faced by developing countries like Pakistan in the adoption and promotion of e-learning. This chapter further discusses the concept of quality in general, quality in e-learning, e-learning quality models and frameworks by highlighting the various quality characteristics in different perspectives. A comprehensive analysis and limitations of the existing quality models and frameworks are also discussed. **Chapter 3** delineates the process of research (research methodology) carried out to achieve the research objectives. The tools, methods and techniques applied during the study are elaborated and explained in this chapter. **Chapter 4** provides an overview of the identification and critical analysis of the most crucial challenges of e-learning systems. The identified challenges are then prioritized following categorization into respective dimensions. One of the top most crucial challenges has been selected as research focus. **Chapter 5** describes the process and outcomes of the Systematic Literature Review conducted to probe the research focus in more detail. **Chapter 6** presents the analysis and results of the data collected from various research activities including quantitative and qualitative methods. Different statistical tools and test are applied to analyze the

collected data in order to extract the quality characteristics for proposition of sustainable quality assessment model for e-learning systems. The extracted quality characteristics are further analyzed to gauge their significance and proportion towards assessment of overall quality of e-learning systems. Results obtained from statistics modeling lead this study to develop the sustainable quality assessment model for e-learning system. **Chapter 7** describes the structure of the proposed model for the quality assessment of e-learning systems for HEIs of developing countries like Pakistan. Furthermore, process guidelines, worst and best case scenarios along with threshold values of the model are also devised in this chapter. **Chapter 8** explains the validation methods performed in order to validate the proposed model. Four different methods including reference to the appropriate existing literature, survey questionnaire from practitioners, survey questionnaire from experts and implication of the developed model in a case study have been consumed to validate the developed model. **Chapter 9** provides the review of the research conducted and conclusion of the study. Moreover, various future guidelines regarding e-learning systems are also suggested.

CHAPTER 2: LITERATURE REVIEW

Literature review is the integration of various results of diverse studies, possessing a value that cannot be compensated by a single study. Review of the literature enables the researcher to obtain answers to various questions. A literature review may link an existing theory with the findings or it may propose a new theory based on its conclusions (Baumeister, 2013).

The first section of this chapter gives an insight from the previous research carried out on e-learning, modes of e-learning and the challenges or problems faced by developing countries like Pakistan in adoption and promotion of e-learning. The second section sheds light on the general concept of quality and quality in e-learning. Furthermore, it also examines state-of-the-art e-learning quality models and frameworks along with various quality characteristics which address different perspectives.

2.1 E-Learning

Online learning has its origin in early 1980s, when Computer Assisted Instruction (CAI) also known as Computer Based Training (CBT) took hold, whereas, the origin of the term e-learning (which is a very broad recent term) is not fully revealed (Kylli, 2005; J. L. Moore et al., 2011). The idea of CAI has been developed as training programs for the students to be executed on a computer. This term is used to describe the wide variety of technologies involved in attaining the concept of "learning beyond the limits". It is mixture of latest technologies including web, which enables us to switch to the modern digital class rooms from our traditional mode of learning.

It is difficult to find a single, comprehensive and exact definition of e-learning from state-of-the-art literature so far (Meredith & Newton, 2003; Nicholson, 2007). According to Ozkan and Koseler (2009), electronic learning means the learning using electronic devices which deliver the contents to the learners. The devices include internet, audio, video, TV, CDROM, satellite and so on. It is commended by Bleimann (2004) that e-learning is a self-directed learning based on web technologies. The author further emphasized that e-learning is actually a collaborative learning. E-learning involves the use of any possible combination of computer, internet, e-mail, fax, and other electronic devices to provide education and training (Shee & Wang, 2008). Due to rapid advancement of internet, the term e-learning generally refers to the circumstances where learning is done via internet, offering online courses (Hassanzadeh et al., 2012; Monahan, McArdle, & Bertolotto, 2008; Y.-S. Wang, Wang, & Shee, 2007). In fact, e-learning systems are Information Systems (IS) that uses World Wide Web (WWW) to deliver learning and training to the learner in an effective and flexible way (J.-K. Lee & Lee, 2008). According to IEEE Technology Standard Committee's, e-learning system is a learning technology in which web browsers are utilized as a tool to interact with learners and other systems. Additionally, this system acts as a platform (LMS, CMS, KMS or VLE) enabling learners to perform the learning and teaching activities (Hassanzadeh et al., 2012). In the last decade the communication medium got very cheap so e-learning is no more beyond the reach of common people. It is already in practice in numerous countries and researchers are improving various aspects of e-learning.

Rapid developments in information technology, new global economy and job market presents complex challenges for the students of universities. These challenges include computer literacy, information analysis, critical thinking, synthesizing skills

and quality. Universities round the globe are looking at the advancements in ICT as the savior for coping with these problems; assuring cost and quality (H.M. Selim, 2007; Hassan M Selim, 2007). Rapid developments in internet technologies make it possible for this universe to become a global village. However, it is not possible to achieve the objective of globalization without global information and global information cannot exist without global education. In order to achieve global education, a paradigm shift is required form traditional education model to this flexible mode of computer mediated learning (e-learning).

Before inception of this flexible learning, it was assumed that teachers are essential for the education process, as according to the opinion of (Freire, 1994) e-learning is new concept which takes exception to the traditional "bucket theory" or the banking concept of education, in which role of an instructor is like a bucket which holds all the knowledge, which is transferred only to those students who attended the class. Similar concept is argued by B. H. Khan (2003) that the courses offered within the boundary of class rooms can be called the closed learning, because it is necessary for the students to be presented physically in the class in order to learn from what taught by the teacher. The author further explained e-learning in terms of open, flexible and distributed learning. Open learning can be defined as the learning according to the suitability of learners' time, pace and place (Calder, 1998; B. H. Khan, 2003).

2.1.1 Difference between Traditional Learning and E-learning

E-learning is becoming mainstream due to its accessibility, state-of-the-art learning, and ease of training, cost effectiveness and flexibility. However, e-learning is a modern shape of traditional distance education system which uses the postal

services for the correspondence between students, teachers and the institutions (Van Der Merwe, Maneschijn, & Goikoetxea, 2006). E-learning and distance learning are similar (Rashid, 2010) due to same objectives (teaching and learning) but a contrasting factor is their mode of communications. The basic difference that makes distance education unique from e-learning is the physical separation of the student from the instructor and the class room; e-learning, on the other hand, becomes part of the classroom environment from the beginning because all learners are coupled with some communication media regardless of their physical locations (Farid et al., 2014). In the beginning this communication was very slow but with the advancement of Information Communication Technology (ICT), we stepped towards a better communication world which uses various electronic modes of communication including computers, mobile devices, high speed internet, and microwave and satellite transmission. These modern technologies have made it possible to communicate between different stakeholders (like learner to learner, teacher to learner, teacher to institution and institution to learner) effectively.

2.1.2 Trend of E-learning

ICT has created new horizons in the form of e-learning. It has generated numerous opportunities in education by extending the potential to reach distant learners for education. By the rapid increase in the usage of ICT, numerous world leading universities are also offering courses through the use of ICT to the distant learners, hence becoming "dual mode universities" (Islam & Selim, 2006) in order to attract more and more learners from the remote areas. In recent years, educational and non-educational institutions are widely deploying web-based learning systems. It is urged by Bhuasiri et al. (2012), that more than 1000 institutions in 50 countries

have adopted e-learning practices. It is reported by Koohang, Riley, Smith, and Schreurs (2009) that online registrations of the learners have been rising extensively faster than enrolments in general in HEIs of US. According to Giga Information Group, approximately 75% of the 129 top US universities are offering educational services using web-based learning systems in 2007 (W.-T. Wang & Wang, 2009). This statistical evidence shows that e-learning is going to be dominant, causing major changes in the field of higher education (Penna & Stara, 2008). Beside widespread adoption of e-learning among higher education institutions the quality assurance and the effectiveness of the delivered contents is still a difficult task to achieve (Baruque et al., 2007).

2.1.3 Modes of E-learning

HEIs must realize the benefits and limitations of different e-learning techniques and modes. E-learning is being happening in two major modes (as illustrated in Table 2.1) including synchronous and asynchronous e-learning (Farid et al., 2014).

a) Asynchronous E-learning

Asynchronous e-learning is facilitated by common media including emails, audio tapes, video tapes, discussion boards or delivering other types of Learning Objects (LOs) and Mobile Learning Objects (MLOs). It does not need the learners and teachers to be online at the same time (Hrastinski, 2008). Asynchronous e-learning is normally happens in offline mode, which is the key factor in flexible learning.

Table 2.1: Modes of e-learning

Dimension	Characteristic	Significance	Example
Synchronicity	Asynchronous	Content delivery occurs at a different time than receipt by the student	Lecture delivered through email
	Synchronous	Content delivery occurs at the same time as receipt by the student	Lecture delivered through web, Video conferencing, chat sessions etc.
Location	Same place	Students use an application at the same physical location as other students and/or the instructor	Using a Group Support System to solve a problem in a classroom
	Distributed	Students use an application at various physical locations, separate from other students and the instructor distributed locations.	Using a Group Support System to solve a problem from web

b) Synchronous E-learning

Synchronous e-learning is live, real-time (usually scheduled), facilitated instruction and learning-oriented interaction. In other words, both teachers and learners are to be present at the real time. This mode of learning also helps learners to ask questions directly to the teacher(s). It is usually supported by communication media including online chat sessions, video conferencing, virtual classroom, webinar, webcasting etc., has the potential to support e-learners in the development of learning communities (Hrastinski, 2008). What all the descriptions have in common is the use of Web conferencing software to support live, interactive (more or less) learning events delivered on the World Wide Web (Hyder, Kwinn, Miazga, & Murray, 2007).

2.2 ICT-Based Initiatives in Pakistan

In Pakistan, higher education facilities are progressively expanding for uplifting its socio-economic condition. HEC is the only government institution striving for promoting higher education in the country. HEC not only supervises all universities and degree awarding institutions in the country to evaluate, improve and promote higher education and research sector in the country but is also responsible for awarding scholarships to the Pakistani students at local and international level for getting higher academic qualifications such as MS and PhD. HEC categorized higher education institutions into three groups; 1) public sector universities, 2) private sector universities, and 3) degree awarding institutes focused in some specialized disciplines. HEC has facilitated all public sector universities by providing funds for the video conferencing system. The purpose behind this project is to promote e-learning by developing world class video conferencing facilities in the all public sector universities. This project will help bridging the gap between international and local faculty members and among students as well (Iqbal & Ahmed, 2010). Consequently it would help in reducing poverty and sustainable economic development of the country. At present, there is a total of 139 universities or degree awarding institutions in the country (Finance, 2014). However, the demand of higher education is running ahead of resources available at formal universities and degree awarding institutions (Khattak, 2010).

Pakistan's education system faces numerous problems at all level especially at higher education level. These problems include acute shortage of qualified faculty, low student motivation, outdated curriculum, unequal opportunities of urban and rural areas, across gender and amongst provinces of the country (Mehnaz Aziz,

2014). Moreover, education sector has always been given lower priority in terms of government and social expenditures. Public expenditure on education is less than 2% of the GDP (Rahman, 2014). The adult literacy rate is 76% in urban and 51% in rural areas with the population of estimated 170 million (Finance, 2014). This lower situation of literacy rate in rural areas of the country is due to the lack of educational facilities, quality teachers and unawareness of the importance of education for the economic betterment of the people. Furthermore, access to higher education is one of the most acute and continual challenge to build up the human capital and transforming it to knowledge based economy. The likelihood of investment in the development of infrastructures to support HEIs to shift from traditional education system to new paradigm of e-learning seems to be challenging due to low budget of government in education sector (I. A. Qureshi et al., 2012). It is required to integrate ICT in higher education system and a paradigm shift is needed from conventional educational system to new computer mediated education model for promoting higher education in the country. This gap is being filled by distance education/e-learning to educate masses nation-wide.

E-learning is still in its infancy of adoption and implementation in the developing countries. As by the end of World War II, the gap of living standard, socio-economic system, food and educational opportunities between developed and developing countries has been widening (Gulati, 2008). Developing countries are facing different challenges in the implementation and promotion of e-learning which are quite different from the developed countries (Bhuasiri et al., 2012; Nawaz, 2012). Many developing countries including Pakistan are eager to implement e-learning (Grönlund & Islam, 2010) but experiencing different problems such as resources, infrastructure, internet access, support from institution, personal characteristics as

well as culture and policy (Bhuasiri et al., 2012; Nawaz, 2012). Economic and law and order situations are at the downward trend in Pakistan, in this current scenario e-learning is the best possible solution to educate and train the people.

Integration of ICT is penetrating in HEIs of the developed countries to establish completely ICT-based universities called virtual universities. Moreover, numerous world leading universities are also offering courses through the use of ICT to the distant learners, so that to become "dual mode universities" (Islam & Selim, 2006). Nevertheless, in the education sector, developing countries are facing shortage of skilled teachers, educational infrastructure, and technology access to enhance the education at different levels (Nawaz, 2012; I. A. Qureshi et al., 2012). According to the policy statements of the international agencies (UNESCO, World Bank, European Commission etc.) open and distance learning is gaining popularity since 1990 (Perraton, 2007). It is observed that lack of resources including furniture, buildings, qualified teachers and learning material are the main obstacles in promoting open and distance learning (Gulati, 2008). In developing countries like Pakistan, ICT has not penetrated to higher magnitude in many HEIs due to various socio-economic and technological considerations (A. Khan, 2007; Sife, Lwoga, & Sanga, 2007).

HEIs of various countries are integrating ICT in education to enhance the learner's experience of learning (Pagram & Pagram, 2006). The trend of swift development in ICT infrastructure can easily be observed in Pakistan since last decade. The Government of Pakistan (GOP) is eager in developing IT infrastructure and to enhance this digital learning in the country however there are cultural, socio-economic and technological constraints in attaining higher literacy rate in the country

(A. Khan, 2007). However, Pakistan has an existing "ICT in Education Master Plan" which was formulated in 2007. This plan describes the strategies to integrate ICT for the expansion of educational prospects, improvement of the student learning and aims to develop capacity of distant education at various levels (HEC, 2013). For this purpose a university named Virtual University of Pakistan and National ICT R&D Fund for lifelong learning has also been established 10 years later. But GOP is still trying to achieve the target i.e. "education for all".

AIOU is one of the mega universities of the world for providing education through distance learning paradigm. It is the first distance learning university of Pakistan which was established in early 1974. With the explosion of ICT, AIOU is also changing its mode of learning to facilitate learners as much as possible. A center for instructional design has been established in AIOU to develop localized Learning Objects (LOs) to facilitate local students at their places. LO can be defined as an entity in electronic form, it may be a text, an audio, a video or a power point presentation, online courses etc. which may also be recognized as an e-learning product or a pedagogical entity (Berger & Rockmann, 2006; Khattak, 2010). According to the opinion of GÜLER and Altun (2010) a resource that can be reusable and digital with the aim of achieving the learning objectives is known as LO. Additionally it is urged by Lau et al. (2013) that LO can be represented by another term known multimedia information, which is the collective set of contents including text, animation, audio, video or image.

E-learning has generated a lot of new opportunities in education by extending the potential to reach new learners to deliver education. This increasing acceptance of e-learning (as discussed in Section 2.1.2) sets up various questions regarding its

quality, e.g. what is the standard of quality e-learning? What characteristics/factors constitute quality of an e-learning system? What are the minimum indicators for the quality of e-learning systems? What are the crucial quality characteristics that higher education institutions must take into consideration when adopting an e-learning environment? Thus it is important and a central challenge to find the answers to questions regarding quality of e-learning system.

2.3 Critical Challenges and their Impact

The state-of-the-art studies on identification of e-learning challenges or issues faced by the HEIs of Pakistan are scattered over the literature. However there is limited work reported in the literature regarding this field of study. An effort has been made by Siddiqui (2007) in identifying some of the issues including technological and institutional infrastructure, computer literacy, English competency, lack of awareness, teacher training and interaction between student and teacher. Iqbal and Ahmed (2010) recognized only a couple of issues like teacher's training, electric power, ICT infrastructure, student's assessment and insufficient funding by focusing only one public sector university and no further discussion has been carried out in their study. Another effort is made by Kundi et al. (2010), highlighting the predictors of success for the e-learning. The authors have focused on user satisfaction and discovered that lack of user training, underestimation, lack of awareness, lack of technical and administrative end-user support and resistance to change are some of the users' problems in e-learning. Moreover, their study is limited to only one province i.e. NWFP (now called Khyber Pakhton Khuwah (KPK)) of Pakistan. Another effort has been made by I. A. Qureshi et al. (2012) in identifying technical difficulties like computer literacy, computer access, security and privacy, face-to-

face interaction, English competency and students' resistance to change as some challenges for the implementation of e-learning. Their study emphasized and limited to only one Private Sector University rather considering other HEIs of Pakistan. Moreover, the authors have emphasized on the implementation level rather than on promotion of e-learning. Some e-learning issues related to developing countries like Pakistan has been identified in Nawaz (2012), by exploring the experiences of the HEIs of advanced states, developing countries and Pakistan. These issues include lack of user perception, ineffective user training, borrowed e-learning models, digital divide and lack of technical support. Some e-learning challenges like lack of knowledge about technology, usage problems and accessibility to e-learning tools have been identified by Farid et al. (2014) through a survey of public sector universities of Pakistan.

Most of the HEIs of the country have started distance-learning programs in various disciplines. Their goal is to adopt this computer mediated learning environment to facilitate learners at their own places. There are numerous hindrances in achieving their goals and objectives. After critical analysis of the reviewed literature and the discussions with the e-learning experts, we have identified 26 critical challenges, which have an impact on the adoption and promotion of e-learning in Pakistan. The identified challenges (both from literature and experts) are shown in **Table 2.2**, some challenges (1 to 16) are common among developed and developing countries like Pakistan and can easily be recognized by the literature, however, there are some challenges (17 to 26) which are unique and have been addressed and highlighted by the studies conducted in the context of HEIs of Pakistan. The identified challenges and their impact in the implementation and promotion of e-learning in Pakistan are discussed in Chapter 4, Section 4.2.

Table 2.2: Identified e-learning critical challenges

No.	Challenges	Literature
1.	Lack of instructional designer	(Ivergård & Hunt, 2005), (Shraim & Khlaif, 2010)
2.	Lack of instructional design process	(Barbosa & Maldonado, 2006)
3.	Lack of software quality assurance process	(Chua & Dyson, 2004), (Babu, 2005)
4.	Bandwidth	(Anuwar & Datuk, 2004), (Homan & Macpherson, 2005)
5.	Lack of formal implementation process	(Kamba, 2009), (Mapuva, 2009), (Q. A. Qureshi, Nawaz, & Khan, 2011), (Masoumi & Lindström, 2012),
6.	Lack of interest of Faculty	(Forman, Nyatanga, & Rich, 2002), (Mapuva, 2009), (Q. A. Qureshi et al., 2011)
7.	Lack of ICT enabled teachers	(Carr, 1999), (Levy, 2003), (Siddiqui, 2007), (Mapuva, 2009), (Shraim & Khlaif, 2010), (Põldoja, Väljataga, Laanpere, & Tammets, 2012), (Nawaz & Khan, 2012)
8.	Lack of ICT enabled students	(Oliver, 2001), (Mapuva, 2009), (Shraim & Khlaif, 2010), (Q. A. Qureshi et al., 2011), (I. A. Qureshi, Ilyas, Yasmin, & Whitty, 2012)
9.	Lack of leadership	(Mapuva, 2009)
10.	Change in universities structure	(Scott, 2000), (Darling, 2002), (Mapuva, 2009)
11.	Software interface design	(A. S. Andersson & Grönlund, 2009)
12.	Support for students	(A. S. Andersson & Grönlund, 2009)
13.	Role of teacher and student	(A. Andersson, 2008)
14.	Support for teachers	(A. S. Andersson & Grönlund, 2009)
15.	E-learning environment	(Holley, 2002; Mapuva, 2009)
16.	Learning style	(Abidin, Rezaee, Abdullah, & Singh, 2011)
17.	Lack of LOs in local language	(A. Andersson, 2008), (Khattak, 2010), (Shraim & Khlaif, 2010), (I. A. Qureshi et al., 2012)
18.	Socio-Cultural Norms	(Iqbal & Ahmed, 2010)
19.	Lack of resources	(A. Andersson, 2008), (Iqbal & Ahmed, 2010)
20.	Accessibility of Internet broadband	(Shraim & Khlaif, 2010), (Farid, Ahmad, Niaz, Itmazi, & Asghar, 2014)
21.	Access to latest computers	(A. Andersson, 2008), (Shraim & Khlaif, 2010), (I. A. Qureshi et al., 2012),
22.	Borrowed e-learning models	(Nawaz, 2012), (Maher Alghali, 2014)
23.	Power failure	(Sangi, 2008), (Kamba, 2009), (Iqbal & Ahmed, 2010), (I. A. Qureshi et al., 2012)
24.	Cost of mobile internet	(Farid, Ahmad, Niaz, et al., 2015)
25.	Practical arrangements for practical oriented courses	(Farid, Ahmad, Niaz, et al., 2015)
26.	Literacy rate	(Farid, Ahmad, Niaz, et al., 2015)

2.4 Quality

It is relatively easy to discuss quality and quality assurance, but it is quite difficult to measure the various characteristics of quality in the different phases of the software development. According to IEEE Standard Glossary of Software Engineering terminology quality is defined as, *"The degree to which a system, component, or process meets specified requirements"*, IEEE further explained quality as *"The degree to which a system, component, or process meets customer or user needs or expectations"*. It is clear from these definitions that quality of software refers to the measurement of various characteristics of software ranging from requirement to implementation. These characteristics include size of product, its complexity, functions implemented, ergonomics factor etc. According to Pressman (2005)*"a product's quality is a function of how much it changes the world for the better"*. It can be concluded easily that quality is vital for survival and success and its importance is universally accepted. The quality of software products is now considered to be an vital element in business success (Jamwal, 2010). The competition in software market is increasing day by day, but no organization can capture this market until unless these do not produce quality systems and services (Bhatti, 2005).

Since 1970s, researchers and practitioners have been looking for ways to characterize software quality. They found that software artifact can be broken down to constructs or quality characteristics that can be assured and measured. This enables evaluation of quality through the evaluation of more detailed characteristics (Nabil, Mosad, & Hefny, 2011). These quality characteristics collectively reflects the overall quality of the system (Al-Qutaish, 2010). Quality itself is difficult to measure

and it is really a critical matter to assure the quality of a software system especially e-learning system. The most important aspects of e-learning quality are user, manager and developer aspects (Abdellatief, 2011; Olsina, Lafuente, & Rossi, 2001; Sanjay Kumar Dubey, 2012). The quality of an e-learning system is two-fold in nature including the educational and software dimensions. There are only few evidences about the efforts to assure the quality of e-learning systems (McGorry, 2003; Moussa & Moussa, 2009).

Assessment of the quality of a software application system is crucial in order to get valuable results in software systems that are efficient, reliable, understandable and acceptable for their stakeholders (I. ISO, 2001). Similarly, it is also necessary to develop and utilize rigorous assessment models and mechanisms in order to facilitate and ensure the continuous quality of web-based application systems like e-learning (Mavromoustakos & Andreou, 2007).

2.4.1 Quality in E-Learning

It has been observed in the recent years that the interest of e-learning practitioners about the quality of e-learning systems have been amplified (Alistair Inglis, 2008; Oliver, 2005). This growing attention about quality assurance initiatives for e-learning cannot be denied (Oliver, 2005; Weaver, Spratt, & Nair, 2008). The increasing concern about quality of e-learning system has led higher education institutions to look for quality assurance frameworks and approaches in order to cope with the quality challenges of their e-learning systems (Alistair Inglis, 2005; Masoumi, 2010). Addressing these quality concerns, now there is significant number of e-learning quality models and frameworks to assure and enhance the quality of e-learning systems (Masoumi, 2010; Masoumi & Lindström, 2012). But still there is

need of such quality frameworks and models that facilitate practitioners and administrators of HEIs in assuring the quality of e-learning system they have already adopted or are going to adopt.

Quality itself is difficult to measure and the quality of a software system is really a critical matter to assure, especially an e-learning system. As there are many stakeholders (including learners, instructors, institutions, administration, software developers, instructional designers, managers, online facilitators, multi-media designers, learning objects developers etc.) of an e-learning system (Abdellatief, 2011; Olsina et al., 2001; Sanjay Kumar Dubey, 2012; H.M. Selim, 2007). All stakeholders have their own views and needs of quality according to their specific requirements. Therefore, it is important while developing an e-learning quality framework, all concerned stakeholders should involve. Moreover, it is also suggested by the literature that while developing e-learning systems, the administrators or policy makers should incline to privilege the reformist approach but practically they adopted technocratic approach (Kundi et al., 2010). Hence, there is still a variation in theory and practice in the evaluation or assurance of quality of an e-learning system (Abdellatief, 2011; Baruque et al., 2007; Caramihai & Severin, 2009; Chua & Dyson, 2004; Kundi et al., 2010; Ozkan & Koseler, 2009; Yunus & Salim, 2008).

2.4.2 E-learning Quality Models and Frameworks

In 2001, an effort has been made by Oliver and Herrington (2001) in which researchers have opted constructivist framework and presented the features determining the online learning. These features are grouped into learning tasks, learning resources and learning supports. Focus of the framework is in educational

perspective. This framework fails to address the software aspect of the e-learning system.

In 2002, a framework for the improvement of quality of e-learning system has presented by Alastair Inglis et al. (2002), that is designed for managing the improvement of all aspects of delivery of online courses. The framework comprises of ten principles of good practice including 1) Informed planning and management of resources, 2) Sustained committed leadership, 3) Improving access for all clients, incorporating equity, and promoting cultural diversity, 4) Understanding the requirements of the learner and reflecting stakeholder requirements, 5) Design, development, and implementation of programs for effective and active learning, 6) Creating confident and committed staff with new competencies, 7) Managing and maintaining the technical infrastructure, 8) Evaluating for continuous improvement, 9) Provision of effective and efficient administrative services and 10) Supporting the needs of learners. Major objective of these principles are to cover the variety of those attributes involved in supporting the delivery of contents in online learning environment. Another effort has been made by the Sloan Consortium (also known as Sloan-C) by presenting a framework known as elements of quality: the Sloan-C framework (J. C. Moore, 2002). The Sloan-C framework addresses five pillars of quality including learning effectiveness, access, student satisfaction, faculty satisfaction and cost effectiveness. This framework facilitates the educators and educational institutions with the methods to improve the quality, scale and breadth with respect to their objectives so that learning becomes accessible and affordable to everyone irrespective of time and place with the wide range of disciplines. However, Sloan-C framework also fails to address the role of software aspect in the quality of e-learning system.

In 2004, Ehlers (2004) proposed that seven quality fields are required for the subjective quality of e-learning. The quality fields proposed by Ehlers are tutor support, co-operation and communication in the course, technology, cost-expectations benefits, information transparency of provider, course structure and didactics. Main emphasis of this study is on the learner perspective focusing from pedagogical point of view, lacking the in depth analyses of the issues related to the design of interactive software system. Another effort in 2004 has been made by Chua and Dyson (2004), the authors proposed ISO 9126 Quality Model as a useful tool for evaluating e-learning systems, especially for teachers and educational management. This work demonstrates the validity of model in a case study in which they apply it to a commonly available e-learning system.

In 2006, a quality framework known as TICS (Technology, Interaction, Content, Services) has been developed by Lanzilotti et al. (2006). Major focus of the TICS is to identify and highlight those dimensions of e-learning systems that can lead to the quality of e-learning systems, so that evaluators and designers may focus on those dimensions to provide a good quality system. The approach is described through combining a particular review inspection called Abstract Task inspection with user testing supported by a set of guidelines to test the e-Learning systems.

In 2007, an effort has also been made by Baruque et al. (2007) by proposing a framework for corporate e-learning evaluation. In their study they have considered the planning, execution and optimization of a corporate e-learning program, standards to control the expected risk in these processes has been defined. These control standards includes organizational aspect, instructional aspect, administrative aspect and technological aspect respectively.

In 2008, a multi-criteria evaluation method for the web-based e-learning system has been proposed by Wang Shee and Wang (2008), their methodology has focused only on one aspect of e-learning i.e. learner satisfaction. Major dimensions of their consideration are learner interface (ease of use, user-friendliness, ease of understanding and operational stability), learning community (ease of discussion with other learners, ease of discussion with teachers, ease of accessing shared data and ease of exchanging learning with the others), system contents (up-to date, sufficient and usefulness) and personalization (capability of controlling learning progress and capability of recording learning performance).

In 2009, Ireland et al. (2009) has presented a framework to develop the quality in e-learning system. Their framework has been divided into three major parts including basic standards for e-learning sites (organization and appearance, consistency and compliance, appropriate use of tools along with learner resources and supports), advance standards (site design driven by learner-centered pedagogy, assessment activities and feedback process, student interaction and engagement, quality online resources and supports along with Academic management of site of a high standard that benefits student learning) and staff development tool kit for e-learning. A major emphasis of the framework is towards pedagogical perspective however factor of usability has been considered in this framework. A process-oriented lifecycle model is devised by Abdous (2009) for assuring the quality of development and delivery in e-learning system. The model has three non-linear sequential phases including a) before (planning and analysis), b) during (design, prototype and production) and c) after (post-production and delivery). Ozkan and Koseler (2009) presented a multi-dimensional Hexagonal E-Learning Assessment Model called HELAM. Existing literature has used it as base, integrating the concept

form both education and information system disciplines to develop HELAM. In this study e-learning has been divided in to two major components; social and technical. These issues have further been classified into other perspectives. The social issues are further divided into supportive factors, learner perspective and instructor attitude, whereas technical issues include system quality, information (content) quality and service quality respectively.

In 2011, Jung (2011) presented the dimensions of e-learning quality from the learner's perspective. The dimensions highlighted in this study are Interaction (faculty, tutors and other students and to both asynchronous and synchronous interactions.), Staff Support (continuous assistance, on-demand training, clear policies and procedures for recruitment, and welfare), Institutional Quality Assurance Mechanism (existence of quality standards and written guidelines for QA in e-learning and periodic internal and external evaluations), Institutional Credibility (acquiring national and international accreditations and strong leadership in the e-learning institution), Learner Support (policy and guidelines for funding and financial management, access to physical library resources, psychological, social and administrative support and learner welfare), Information and Publicity (provision of course-related and other logistic information in a clear and detailed manner and on the Internet) and Learning Tasks (provision of collaborative, individualized and problem-based learning tasks).

In 2012, an e-quality framework focusing on the issues related to the enhancing and assurance of the quality in e-learning presented by Masoumi and Lindström (2012). Major factors addressed by their framework are institutional factor (institutional affairs, administrative affairs, research and reputation),

instructional design factor (clarifying expectations, personalization, selecting proper learning scenarios, organizing learning resources and currency and accuracy of learning resources), evaluation factor (cost-effectiveness, learning effectiveness, student satisfaction and teacher satisfaction), faculty support (technical assistance in course development, administrative support and pedagogical support), student support (administrative support and technical support), pedagogical factor (student centeredness, communication and interactivity, social aspect, learning environment, assessment and learning resources) and technical factor (development and sustainability of technological infrastructure, functionality of technological platforms, accessibility and interface design).

In 2016, a quality model for e-learning system has been proposed by Djouab and Bari (2016). ISO 9126 software quality model has been adapted to propose an extended e-learning quality model. Neither validation nor guidelines for the utilization of the proposed model has been devised.

2.4.3 Limitations of the Previous Work

A number of quality models and frameworks have been explored during this study. Certain limitations have been perceived in the previously proposed models and frameworks for the quality of e-learning systems;

a) Addressing Pedagogical Issues

Most of the identified studies (80%) have been addressing various aspects of pedagogical activities. These identified studies are deficient to address the software characteristics of e-learning system. However, few studies have highlighted mere quality characteristics of e-learning systems like usability, efficiency, portability,

reliability etc. of software perspective (Abdellatief, 2011; Ardito et al., 2006; Chua & Dyson, 2004; Djouab & Bari, 2016). The quality of an e-learning system cannot be measured on the basis of few characteristics like usability, functionality or efficiency (Hassanzadeh et al., 2012; Alistair Inglis, 2008). In order to avail and enhance the quality of e-learning system, other quality characteristics like security, availability, charisma, scalability, extensibility etc. are also crucial to be addressed and measured. Hence, a novel framework is required to address appropriate characteristics of an e-learning system.

b) Validation of the Proposed Frameworks or Models

On the basis of SLR performed for this study, it has been perceived that most of existing quality models (53%) proposed by the previous studies (Abdous, 2009; Baruque et al., 2007; Ehlers, 2004; Alastair Inglis et al., 2002; Ireland et al., 2009; Masoumi & Lindström, 2012; J. C. Moore, 2002; Padayachee et al., 2010) are not validated or tested comprehensively on any of the existing e-learning system. Moreover these are also lacking to define the guidelines or processes on how to utilize these models. So far that there is need to propose such a quality model or framework that must include the set of guidelines about its usage.

c) Addressing the Future Needs of HEIs

E-learning is growing rapidly, hence the needs of the HEIs for the quality assurance and assessment of their e-learning tools is also demanding such type of quality models that can cope with this rapid changing environment. The state-of-the-art quality models are not adequate enough to address such quality characteristics that can accommodate the future needs (extensibility, portability, maintainability,

etc.) of the institutions in order to assure the quality of their e-learning systems. Hence, a sustainable quality assessment model is required to consider the future needs of the higher education institutions.

2.4.4 Analysis of E-Learning Quality Models and Frameworks

Several frameworks and models as illustrated in Table 2.3 have been proposed for the quality assessment of e-learning systems. These models have been designed for the quality assessment or evaluation of e-learning systems in developed countries or in Western contexts (Masoumi, 2010). As developing countries are facing problems that are different from those faced by developed countries (Bhuasiri et al., 2012; Farid, Ahmad, & Alam, 2015). In other words, these models and frameworks may not be appropriate for the localized environment of the developing countries with distinct social and cultural backgrounds. Therefore, different questions arise on the effectiveness, reliability and suitability of these e-learning quality frameworks and models formed in other contexts (Fresen & Boyd, 2005). Moreover, these models have not addressed the software perspective of e-learning system. Based on the literature review, only 29% of the quality models have been proposed considering software perspective as shown in Table 2.3. Whereas, software perspective of the e-learning systems have been emerged as an important perspective which not only deals with the development of LOs but also with the development of e-learning tools like LMS, CMS etc. (Farid, Ahmad, & Alam, 2015). However, it is quite clear from Table 2.3 that there are some evidences in which there is tendency to address only few aspects of software perspective, i.e. user interface or usability has been taken into consideration.

A very limited attention is given to the quality of e-learning tools like LMS, CMS, VLE, KMS etc. (Padayachee et al., 2010) in spite of the importance of quality and its effect on adoption and promotion of e-learning systems. As quality of an e-learning system (software aspect) cannot be measured with a single factor (such as usability, accessibility, efficiency etc.) until and unless other factors like availability of the e-learning system, ability to use different devices (smart phones, tablets, laptops or desktops) independent of operating system and specifications, flexibility, accessibility, reliability, security etc. are not taken in to account (Y.-S. Wang et al., 2007). This discussion leads to the argument that the development of a quality assessment mechanism for assessing and enhancing quality of e-learning systems of developing countries like Pakistan is crucial and is the need of the hour.

Table 2.3: Comparison of e-learning quality models and frameworks.

Characteristics	(Oliver, 2001)	(Alastair Inglis et al., 2002)	(J. C. Moore, 2002)	(Chua & Dyson, 2004)	(Ehlers, 2004)	(Ardito et al., 2006)	(Lanzilotti et al., 2006)	(Baruque et al., 2007)	(Shee & Wang, 2008)	(Ireland et al., 2009)	(Abdous, 2009)	(Ozkan & Koseler, 2009)	(Padayachee et al., 2010)	(Jung, 2011)	(Abdellatief, 2011)	(Masoumi & Lindström, 2012)	(Djouab & Bari, 2016)
Major Perspective*	P	P	P	S	P	S	P	P	P	P	P	P	S	P	S	P	S
Content/ID		X			X		X	X	X	X	X	X				X	
Delivery		X									X						
Evaluation																X	
Instructor/Faculty			X		X							X				X	
Institution														X		X	
Admin		X						X		X				X			
Learner		X	X		X				X	X		X		X		X	
Technology/I.T.					X		X	X				X			X	X	
Cost			X		X												
Return on investment																	X

Access			X														
Learning activities	X		X			X								X			
Personalization									X								
Services							X					X			X		
Social												X					
Interaction / Co-operation					X	X								X			
Interface							X										
Functionality				X									X		X		X
Reliability				X									X		X		X
Performance															X		
Usability				X			X		X	X		Partial	X				X
Teaching						X											
Learning Environment						X											
Efficiency				X									X				X
Portability																	X
Maintainability																	X
*P = Pedagogical, S = Software																	

2.5 Summary

This chapter examined the previous research work carried out on e-learning. Critical challenges encountered by HEIs of developing countries such as Pakistan have been identified. Some of the identified challenges like lack of software interface design, lack of formal implementation process, and lack of software quality assessment process are considered to be the most crucial for the adoption and promotion of e-learning in the country. This chapter also elaborated the general concept of quality and quality in e-learning systems. Various e-learning quality models and frameworks that were introduced addressing several quality characteristics in different perspectives were also highlighted in this chapter. These quality characteristics include contents, usability, service, cost, reliability, personalization and institutions as depicted in Table 2.3. A comprehensive analysis of the identified challenges, their impact in the implementation and promotion of e-learning and prioritization with respect to their criticality in terms of a hierarchal model is presented in Chapter 4.

CHAPTER 3: RESEARCH METHODOLOGY

The process of acquiring knowledge to a research problem consists of various steps. Research gaps need to be identified from existing literature before proceeding with the research. An exploratory study is conducted in order to understand and verify the identified problems (e-learning challenges) from literature. The impact of these problems is analyzed and one of the top crucial problems is taken as research focus after prioritization. The research focus springs out the demand for a suitable solution. Hence, selection of an appropriate research methodology is vital to achieve the research focus. This chapter explicates the utilized methods comprehensively adopted to conduct this study. The first section of the chapter briefly explains the research philosophy, population of the study, sampling procedure and ways of data collection. Various statistical methods have been used to analyze the collected data quantitatively. These methods include PCA, Logistic Regression, Chi-Square and Kappa statistics are described. Finally the chapter encapsulates the methods used to validate the proposed model following the statistical techniques used to analyze the data in order to accomplish the research objective 5. The whole process followed for this dissertation is illustrating in Figure 3.1.

3.1 Research Philosophy

Pragmatic philosophy is chosen in order to fulfill the research objectives of this research. The researcher emphasizes on the research problem instead of focusing on methods and utilizes all available approaches to understand the problem (Creswell, 2013).

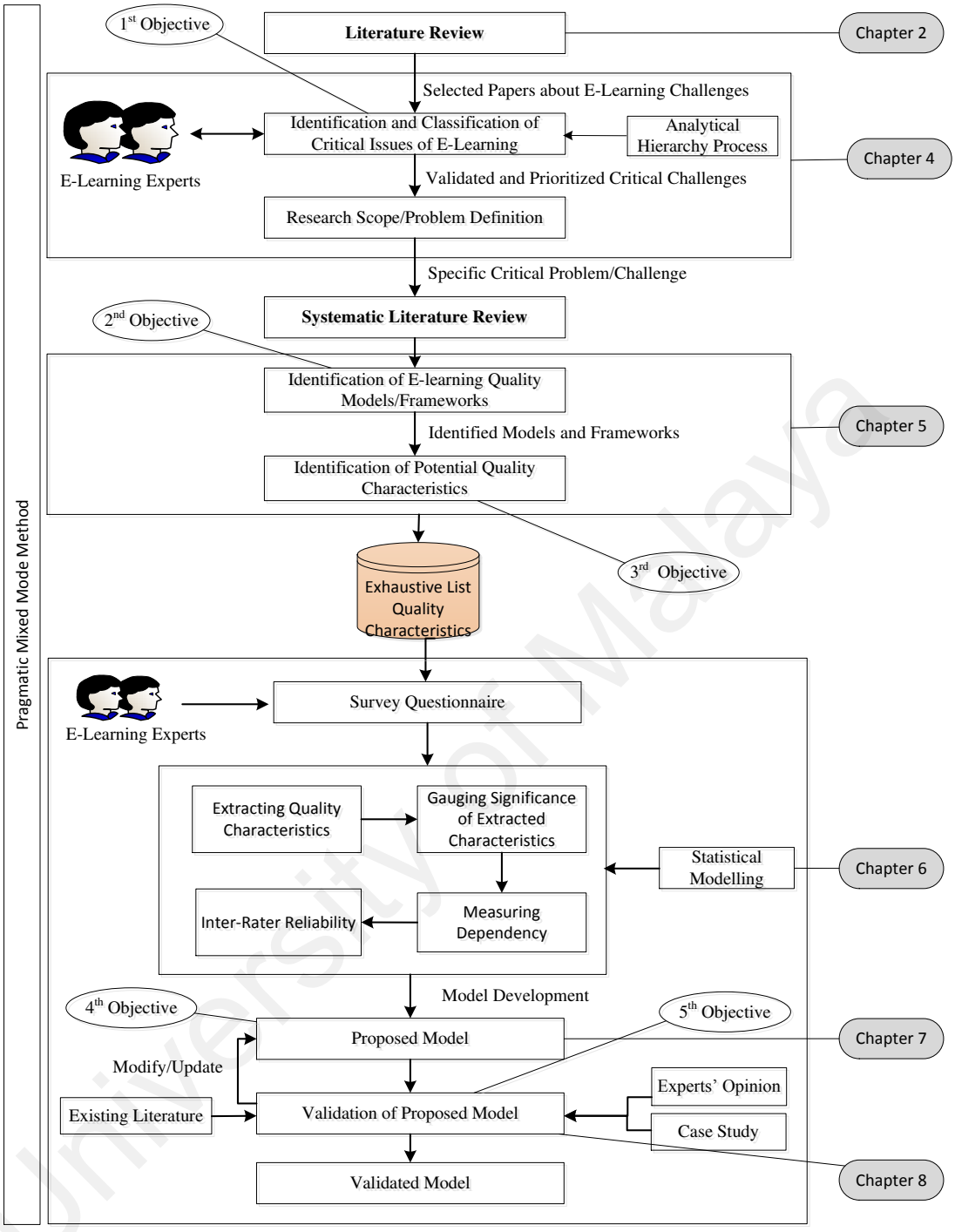


Figure 3.1: Research process followed for this dissertation

The philosophical bases for adopting pragmatic paradigm defined in literature (Creswell, 2013) are;

a) It focuses on efforts employed by the researchers in understanding and interpreting a particular phenomenon (i.e. quality assessment of e-learning systems in developing countries like Pakistan).
b) It provides freedom to researchers in selecting the appropriate procedures, methods and techniques of research to meet their needs and objectives (e.g. interviews, focus groups, experts' opinion, survey questionnaires etc.).
c) Pragmatists do not see the world as an absolute unity. Similarly, mixed methods researchers (integration of qualitative and quantitative) utilize many approaches to collect and analyze data instead of adopting only one method (e.g. quantitative or qualitative).
d) Pragmatism employs integrated methods that enable researchers to draw liberally from both quantitative and qualitative assumptions when they involve in their research activities.

Pragmatism is one of the paradigms that provide an underlying philosophical framework for mixed methods research, i.e. the primary philosophy of mixed research is that of pragmatism (Johnson, Onwuegbuzie, & Turner, 2007; Tashakkori & Teddlie, 2010). Hence, pragmatism reveals the opportunities to access multiple methods and as well as various forms of data collection and analysis for the mixed methods researcher (Creswell, 2013). The mixed method is broadly utilized in numerous fields including behavioral, social, health sciences and in applied sciences as well (Castro et al., 2010; Creswell et al., 2011).

In mixed methods research, the qualitative and quantitative data provides a better picture by exploring in-depth knowledge of the participants' perspective. The integrated research (mixed mode) design is preferred when only one approach is

considered to be inadequate. It attempts to seek an effective intermediate solution for numerous research problems by fully utilizing the advantages of both viewpoints (Creswell & Clark, 2007; Johnson et al., 2007). It is urged by Johnson et al. (2007) that mixed methods research is an approach to knowledge (theory and practice) that attempts to consider multiple viewpoints, perspectives, positions, and standpoints (always including the standpoints of qualitative and quantitative research). An interconnected framework for research design is shown in Figure 3.2.

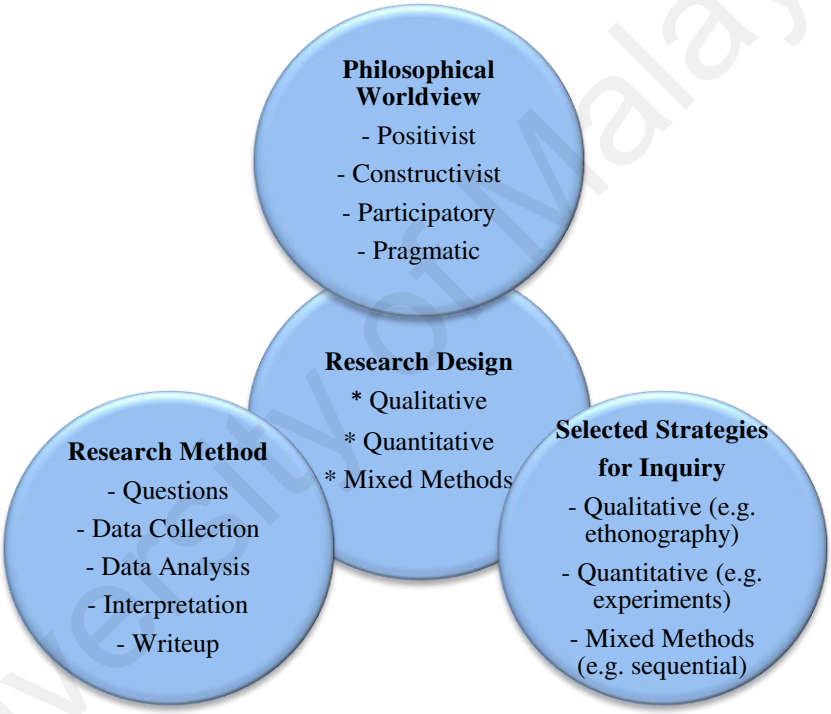


Figure 3.2: An interconnected framework for research design (Creswell, 2013).

3.2 Research Design for Model Development

Sequential mixed mode research has adopted along with employing various research methods in order to collect data. As mixed method research is "practical" in

which the researcher is independent of using all the appropriate methods suitable to address a research problem by collecting data (Creswell & Clark, 2007). This data collection helps in understanding the problems and also in devising, addressing and attaining the research focus by presenting the actual situation concerning the quality of e-learning systems. Quantitative data has collected using survey instrument which led this research towards the selection of appropriate quality characteristics for the development of sustainable quality assessment model for e-learning system. However, qualitative data has been captured using semi-structured interviews with e-learning experts to identify the quality sub-characteristics associated with each quality characteristics at level one of the model. This is an explanatory integrated method, which involve collecting qualitative data after quantitative activity.

3.2.1 Sample

The first step in the research design is to select the sample. The sample selected for this study consists of experts having at least five years of experience in three major fields of e-learning namely academia, software development and administration. Utmost care has been taken in selecting these experts. The experts from academia and e-learning administration have been selected from different public sector universities of Pakistan which have adopted e-learning as one of the mode of education. The software development experts have been selected from the software industry of Pakistan having experience in developing various e-learning applications. Major data gathering sources of this study are illustrated in Figure 3.3.

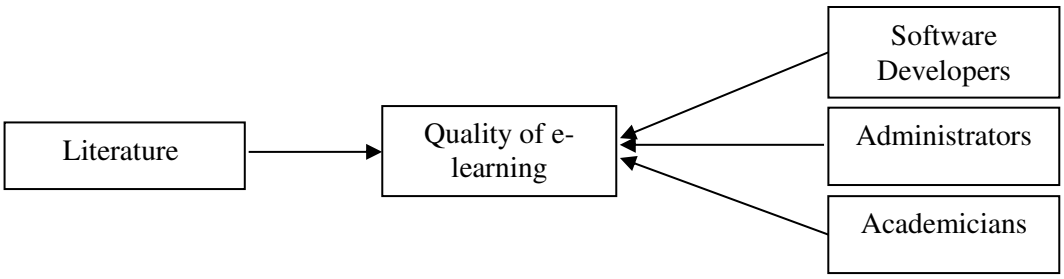


Figure 3.3: Data gathering sources

3.2.2 Data Gathering

Data gathering is the most important and common activity in conducting the research. It is a difficult as well as a complex task. Numerous methods can be used to collect the data such as face to face interviews, telephone interviews, data sampling, written material, documentations, survey questionnaires and observations (Kajornboon, 2005). Data gathering process is divided into two phases. During first phase, the method of survey questionnaire (quantitative) is adopted for the purpose of finding the most crucial and mandatory quality characteristics for the proposition of quality assessment model for e-learning systems in software perspective for HEIs of Pakistan. During the second phase of this study, session of semi-structured telephonic interview (qualitative) with experts has been conducted. The major aims of conducting semi-structure interviews at this stage are to 1) discuss the extracted quality characteristics (from quantitative analysis) and 2) discuss the sub-characteristics associated with the characteristics at level one of the model.

3.2.2.1 Survey Instrument

Survey instrument includes the collection of data from targeted population (individuals or group(s)) through their responses to questions. It is an effective and efficient method of data collection that can collect data from many people at comparatively lower cost and time. An open ended survey questionnaire of potential e-learning quality characteristics has been formulated on the basis of SLR reviewing more than 70 published research papers, articles, case studies from various well renowned journals and conferences. Open-ended survey is considered to be less bias as compared to its counterpart, which may limit experts' opinion (Hasson, Keeney, & McKenna, 2000). The instrument (Appendix-C) is divided into three major sections i.e. a) education, b) software and c) miscellaneous. The quality characteristics reflecting various pedagogical activities are grouped in educational section. Whereas, the characteristics addressed to represent the quality of e-learning software systems are grouped in software section. Beside these two perspectives, there have been identified few quality characteristics that neither fall in pedagogical aspect nor in software aspect like it-ability, emotional intelligence etc. (on the basis of pilot survey) are grouped in third category miscellaneous. There are total forty-two (42) quality characteristics (items) in the instrument. Fourteen (14) characteristics are addressing different features of pedagogical perspective; twenty-four (24) characteristics are addressing the quality of software perspective of e-learning systems; however four (4) characteristics are placed in misc. aspect for the quality assessment of e-learning systems. Items distribution of the survey instrument is depicted in **Table 3.1**.

Table 3.1: Items distribution of survey instrument.

Sections	Items distribution	Number of Items
Education	a to n	14
Software	a to x	24
Miscellaneous	a to d	04
Total		42

3.2.2.2 Interviews

The interviews have been conducted from April 2015 to May 2015. In order to identify the sub-characteristics associated with the quality characteristics extracted for the proposition of the sustainable quality assessment model for e-learning systems. Experiences, observations and opinions of the researchers from the existing literature have been examined and analyzed. On the basis of the literature review and results obtained using statistical tests, an interview plan has been formulated to be used for semi-structured telephonic interviews.

This plan has been checked and validated by two e-learning experts to assure its relevancy and clarity. The method of interviews is adopted for the purpose of finding the facts (sub-characteristics associated with quality characteristics) regarding this study. Interviews are a systematic way of finding facts from people through directed conversation. There are various motives for conducting interviews as a qualitative data gathering tool, some are summarized here:

1. It provides us opportunity to probe in the depth of the topic (Bailey, 2008).
2. It is possible for the researcher to attain highly personalized data from the respondent (Gray, 2004).

3. Maximum return rate as compared to questionnaires is possible to achieve (Austin, 1981).
4. Researcher can validate the response of the respondent by observing non-verbal behavior (Gorden, 1975).
5. Researcher can easily monitor that all respondents have answered all the question (Bailey, 2008).
6. It is an easy way for those respondents who are not well-educated and hesitant to write the answer in their native language (Bailey, 2008; Gray, 2004).

Semi-structured interviews methodology has been adopted to conduct the interviews of e-learning experts. This technique has been utilized due to its advantages over the structured and unstructured methods, including flexibility of asking the questions. Sequence of the questions can be changed according to the direction of the interview and it is not necessary to follow the interview plan strictly (Kajornboon, 2005). Hence additional questions can also be asked to get a clear picture of the issue. These interviews are well suited for the exploratory studies (Barriball & While, 1994) in which, sometimes it is required to investigate the issue in more depth to clarify the opinion of the respondent to reach to an acceptable answer in case of complex and sensitive questions (Bailey, 2008). It is recommended by Patton (2002) that this method is used to ask the question to explore, probe and clarify the particular subject.

3.2.3 Reliability and Validity

Reliability can be defined as the consistency or repeatability of a test or measurement. Whereas validity refers to the degree that an instrument actually measures what it is designed or intended to measure (Laura J Burton & Stephanie M

Mazerolle, 2011). If a researcher wants to present the findings obtained from the survey with confidence, then it is necessary to measure the reliability and validity of the survey instrument before conducting the survey.

a) Internal Reliability

Reliability is one of the major challenges when a psychological test is used to quantity some features or behavior (Rosenthal & Rosnow, 1991). In other words, reliability is the extent to which measurements are repeatable. If different people perform the measurements under different situations, on different occasions, with supposedly alternative instruments which measures the same thing, results should not differ much (Drost, 2011).

There are a numerous aspects of reliability. One of the main issues concerns the scale's internal consistency. It can be explained as the degree to which the items that constitute the scale 'hang together'. Whether, all items of the scale are measuring the same underlying construct or not? One of the most commonly used indicators of internal consistency is Cronbach's alpha coefficient (Pallant, 2010). This statistic provides an indication of the average correlation among all of the items that make up the scale. The value of Cronbach's alpha ranges from 0 to 1, with higher values representing greater internal reliability, however, minimum level is considered to be 0.7 (Nunnally Jum & Bernstein Ira, 1978). However threshold values and level of reliability can be assessed according to the guidelines provided in Table 3.2;

Table 3.2: Guidelines to assess reliability (George & Mallery, 2003)

Cronbach's Alpha Coefficient	Reliability
0.9	Excellent
0.8	Good
0.7	Acceptable
0.6	Questionable
0.5	Poor
0.4	Unacceptable

b) Face Validity

Face validity is the process of validating the survey instrument and refers to the degree that an instrument actually measures what it is designed or intended to measure (Netemeyer, Bearden, & Sharma, 2003). It is a qualitative measure of validity and is often deployed in survey research as it is easy to ascertain (Arnold, Gansneder, & Perrin, 2005).

Face validity is secured using panel; of experts who judge the survey's appearance, relevance and representation of its items (Laura J. Burton & Stephanie M. Mazerolle, 2011). The instrument is given to other researcher(s) and requests them to check whether the test is valid measure of the concept being measured or not (Gaber, 2010). The survey instrument of this study is sent to two e-learning experts in order to check the face validity by looking at 1) sampling error and 2) researcher bias. The survey instrument has been modified by incorporating the suggestions and feedback from the researchers.

3.3 Pilot Study

Before conducting the survey, a pilot test is performed not only to check the validity and reliability of the survey instrument but also to minimize the researchers'

bias regarding the categorization of quality characteristics of e-learning systems. This pilot test was conducted with four e-learning experts having minimum of five years of experience (one expert from each field of e-learning i.e. academia, research, administration and software development). The questionnaire was altered by adding some additional quality characteristics on the basis of input from experts. Some differences were also observed regarding the inclusion of quality characteristics in relevant perspective (pedagogical or software). This process was repeated twice to overcome the disagreements between the experts' opinions in including and excluding some of the issues or challenges considering different dimensions.

3.4 Data Collection Procedure

Data collection is one the major and complex activity in any research. Both quantitative and qualitative methods have been adopted for the data collection keeping in view the nature of pragmatic mixed mode methods.

a) Quantitative

Open ended survey instrument was sent to the sampled sixty-three (63) e-learning experts from targeted public sector universities of Pakistan. Fifty (53) participants responded hence a response rate of 84% was obtained. Three incomplete responses were excluded. The survey was conducted from November 2014 to January 2015 in HEIs of Pakistan. Most of the responses were collected personally. However, some responses were sent by courier service (to save time) where it was difficult to visit personally due to constraints of time and expenses.

Sampled experts of this study were requested to provide view point based on their opinion and experience using five-point Likert scale from Not Crucial (=1) to

Most Crucial (=5) mentioning that which quality factor is required for the said quality assessment model for the localized environment of Pakistan. Moreover, the participants were further requested that in case they feel any quality factor(s)/characteristic(s) missing, they could add that factor at the end of the list along with its definition and/or rationale. Once the experts had completed, the survey instruments were obtained for further analysis using statistical analysis models in order to propose the quality assessment model for e-learning systems. Scale values assigned to each of the five responses are as;

Level of Agreement	**Scale Values**
Most Important (MI)	5
Important (I)	4
Normal (N)	3
Least Important (LI)	2
Unimportant (UI)	1

b) Qualitative

Semi-structure telephonic interviews were conducted with three (3) volunteer e-learning experts from different public sector universities of Pakistan. The experts had more than ten (10) years of working experience. One expert belonged to software development area (developing LOs or e-products for the e-learning systems) and one from administration, performing administrating duties in providing e-facilities to learners. Beside these, we found one expert who had experience of working as an administrator in instructional design department, as an educationist and as a researcher in the field of e-learning. It is pertinent to highlight that these selected experts have also participated in the quantitative phase of this study. Interviews have been conducted using online services like Skype and Viber. It was

demanded by the experts to facilitate them with the list of extracted quality characteristics (along with all associated potential sub-characteristics identified from intense literature review and SLR) before the interview was conducted. The major reason for this was their tight schedule and nature of job. Interviews were conducted at ease and availability of the targeted experts.

3.5 Data Analysis

In order to meet the research object 4, the collected data from our targeted participants is analyzed using various statistical tests like Principal Component Analysis (PCA), Kappa analysis, Logistic Regression and Chi-square. Two of the popular statistical software including Minitab version 17 and Stat Graphics version 16 were used to achieve the objective 4. The analysis reveals ten quality characteristics as crucial for the localized e-learning environment. This activity comprises of two major steps including model specification and model selection.

3.5.1 Principal Component Analysis

Principal Component Analysis (PCA) is one of the most common approaches used for factor reduction. It takes a large set of variables and looks for a way that the variables may be 'reduced' or summarized using a smaller set of factors or components (Pallant, 2010). PCA or sometimes known as factor analysis are similar in nature, the only difference exists in their procedures. In principal component analysis the original variable is transformed into smaller set of linear combination, whereas in factor analysis by using a mathematical model factors are estimated and only shared variances are examined. The proportion of each item (quality characteristic) is measured in order to identify its impact on overall quality of e-

learning systems. The items with too small proportion (say ≤0.03 in this case) can be negligible, as the overall quality of system cannot affect with such small proportion.

3.5.2 Logistic Regression

Regression analysis is used to identify the input factors towards the output or response. The logistic regression analysis, a special case of regression analysis, where response variable follows the exponential family of distribution rather than normal distribution, which facilitates to test the association and significance of the relationships between a response and one or more covariates or quality characteristics. The independent variable can either be categorical or continuous or a mix of both in the same model (Agresti, 2013; McCullagh, Nelder, & McCullagh, 1989; Pallant, 2010). Furthermore, while using logistic regression, goodness of fit is also measured by Hosmer Lemeshow, Pearson and deviance tests. The significance of the covariates and also the goodness of fit of the model is to be monitored by the use of p-value. Logistic regression model is written as;

$$Y = \frac{\exp^{\left[\beta_o + \sum_{k=1}^{42} \beta_{iXi}\right]}}{1 + \exp^{\left[\beta_o + \sum_{k=1}^{42} \beta_{iXi}\right]}} \tag{3.1}$$

Where, k is the number of covariates or factors that are potential candidates for the inclusion in the model. In the model, β_i is the change in log of odds due to the change in the category of χ_i. A quality characteristic χ_i, is significant if the value of $P \leq 0.05$ for χ_i. Significant means that this quality characteristic χ_i is crucial toward the overall quality of e-learning systems.

3.5.3 Comparison of Proportions

This procedure tests the hypothesis that the respondents' responses towards quality characteristics are all identical or all equal proportionate. It also generates an analysis of means (ANOM) plot to determine which samples are significantly different from the grand mean. The chi-square test compares each of the sample values to their grand mean. The P-value ≥ 0.05, reflecting that there are no significant differences between the samples at higher confidence level.

3.5.4 Kappa Statistics

Kappa statistics analysis is used to check the concordance and level of agreement between raters (experts in this case). It quantifies the agreement between observers or raters that classify the same *n* number of items (quality characteristics) into the same *k* nominal or ordinal categories(Muñoz & Bangdiwala, 1997). The Kappa statistic is computed as;

$$K = \frac{\sum_{i=1}^{l} \pi_{ii} - \sum_{i=1}^{l} \pi_{i+}\pi_{+i}}{1 - \sum_{i=1}^{l} \pi_{i+}\pi_{+i}} \tag{3.2}$$

The numerator of K measures the difference between the observed probabilities of agreement and the expected probability of agreement computed under independence. Whereas, the denominator measures the maximum possible difference, which is the difference between perfect agreement (value of 1) and the expected probability of agreement under independence. It is important to note that under independence the numerator would be zero i.e. k = 0, and under perfect agreement the numerator and denominator would be equal to each other so k = 1.

Therefore, the maximum value of Kappa i.e. K = +1 which is considered to be perfect agreement, and a value K = 0 denotes that there is no agreement beyond chance. Threshold values and strength of the agreement between raters is depicted in Table 3.3.

Table 3.3: Strength of agreement (Landis & Koch, 1977)

Kappa Statistics	Strength of agreement
< 0	Poor
0 – 0.2	Slight
0.2 – 0.4	Fair
0.4 – 0.6	Moderate
0.6 – 0.8	Substantial
0.8 – 1.0	Almost Perfect

3.5.5 Association of Quality Characteristics

The chi-square analysis is used to test the association or independence between factors (quality characteristics here). Chai-square test is determined as;

$$\chi^2 = \sum_i \frac{(O_i - E_i)^2}{E_i} \tag{3.3}$$

Where $i = 1, 2, \ldots, k$ and k is the number of cells in contingency table and O represents the observed frequencies in the contingency table and E are corresponding expected frequencies.

3.6 Handling Qualitative Data

Producing written version of the interview is called transcribing. It is a time consuming process. Approximately, it can take more than two and half hours to transcribe a thirty minute interview (Hancock, Ockleford, & Windridge, 1998). In

order to make the sample fair and unbiased we have selected e-learning experts from various fields of e-learning from different universities which have adopted e-learning as one of the mode of education. These fields include academia, software development and e-learning administration. The software development experts have been selected from software industry and from those universities developing in house e-products. Care has been taken to select only those experts who have sufficient experience in their fields with in the e-learning environment.

3.7 Constructing the Solution Area

Systematic literature review (Chapter 5) is performed following Kitchenham & Charters (2007) in order to construct the solution area by exploring the research focus in detail. State-of-the-art quality models and frameworks of the e-learning systems are identified and analyzed critically. Limitations of the identified studies are also investigated to propose a sustainable model for the quality assessment of e-learning systems.

3.8 Validation

It is urged by Kitchenham (1996) that an object which is required to be evaluated can have a specific method, a generic method or a possibly a tool (software application). In this research, the evaluation object is a specific method that is the quality assessment model for the e-learning systems. Most appropriate methods have been chosen for the evaluation requirements of this work as suggested by different studies (Creswell, 2013; Easterbrook, Singer, Storey, & Damian, 2008). The proposed solution of the research focus has been validated following four validation methods as suggested by Creswell (2013) and Inglis (2008). These methods include

by reference to the most appropriate existing literature, survey questionnaire from practitioners to evaluate the applicability of the model, survey questionnaire with e-learning experts to gauge the utility of the proposed model and conducting a case study by applying the proposed model on an existing e-learning system of one of the HEIs of Pakistan. Validation methods and analysis of results are discussed in chapter 8 in detail.

3.9 Summary

This chapter provided an outline of the activities involved in conducting this research to develop a quality assessment model for e-learning systems that based on software perspective. An overview of major activities performed during this research is displayed in Figure 3.4. Pragmatic sequential mixed mode approach was adopted employing different data collection methods like interviews, survey questionnaire and experts' opinion.

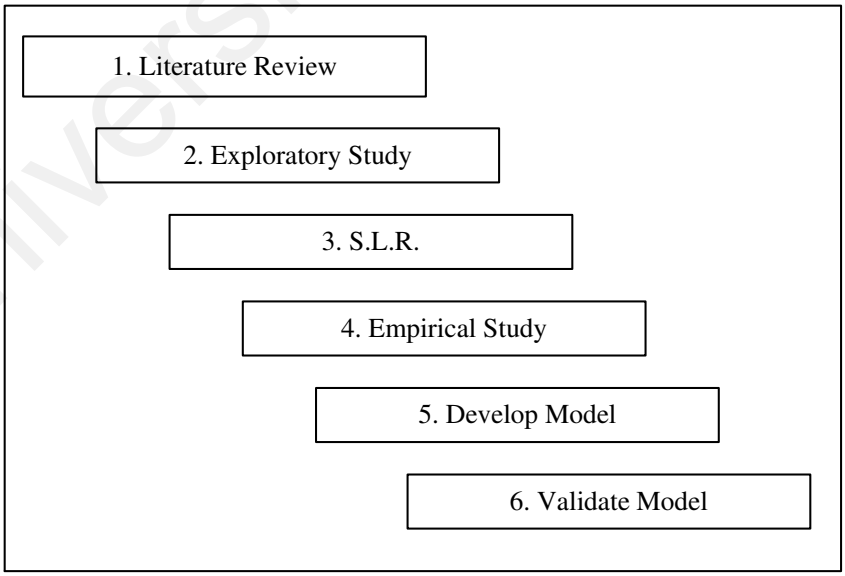


Figure 3.4: An overview of major activities performed during this research

Moreover, different statistical models that were applied to analyze the collected data were also elaborated in this chapter. These statistical models include PCA, Logistic Regression, Chi-square and Analysis of Means that lead this study to propose the sustainable quality assessment model for e-learning systems. This chapter also shed light on the methods for the validation of the proposed model. Results obtained from these statistical tests are discussed in Chapter 6 to formulate the sustainable quality assessment model for e-learning systems. Furthermore, results obtained from empirical investigation of the validation methods are discussed in Chapter 8.

CHAPTER 4: FORMULATION OF RESEARCH FOCUS THROUGH INVESTIGATIONS AND ANALYSIS

This chapter presents identification of critical e-learning challenges faced by HEIs of developing countries such as Pakistan. In order to achieve the research objective 1, an exploratory study is conducted using an extensive review of the existing literature and informal discussions with experts. The goal of conducting the exploratory study was to identify the challenges, issues and problems encountered by HEIs of developed countries in general and developing countries specifically (RQ1.1). This chapter further discusses the analysis of the identified challenges and their impact on the implementation and promotion of e-learning in Pakistan (RQ1.2). An open ended survey questionnaire has been conducted from experts' to filter the identified critical challenges. Factor analysis method has been employed to filter the most crucial e-learning challenges in context of HEIs of Pakistan. A hierarchal model for e-learning challenges has been developed applying Analytical Hierarchy Process (AHP) to answer the research question RQ1.3 following categorization of the extracted challenges into respective dimensions.

4.1 Approach for Formulating Research Focus

The aim of this exploratory study was to focus on identification, detailed evaluation, and prioritization of the challenges according to their importance. These challenges are classified into various dimensions by devising a hierarchical model for the challenges that influence integration of ICT in HEIs. In order to formulate the research focus for this dissertation, AHP was adopted to ensure the precise prioritization of the identified challenges; so that whole range of challenges along

with their priorities can be viewed in hieratical fashion. Figure 4.1 is depicting the research approach for this exploratory study.

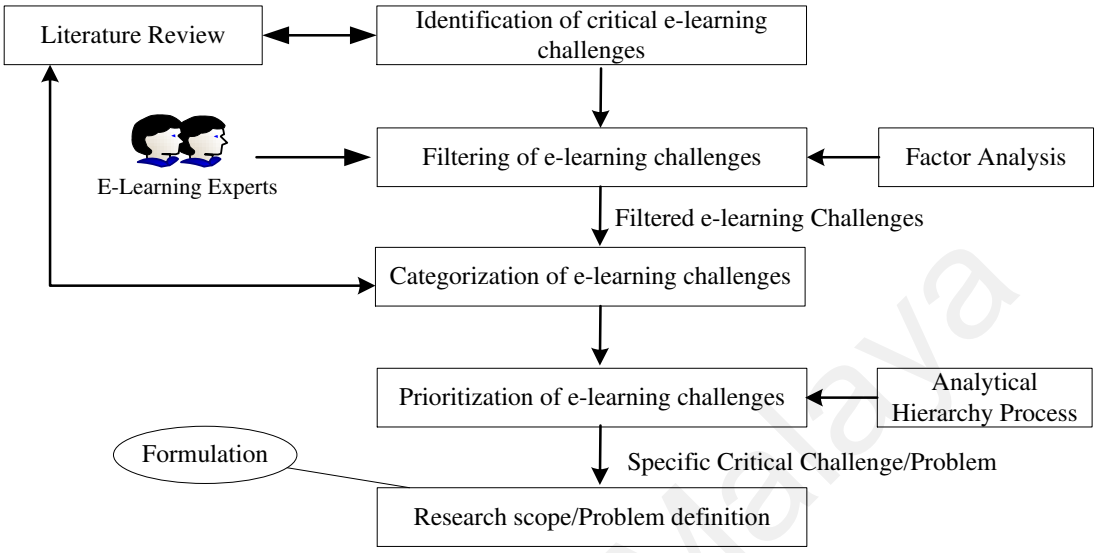


Figure 4.1: Approach for the formulation of research focus.

4.2 Identified challenges and their impact

The identified challenges are elaborated along with their positive or negative impact on the implementation and promotion of e-learning in Pakistan. These identified challenges are already summarized in Section 2.3 and Table 2.2.

4.2.1 Localized Learning Objects in Local Language

The concept of Learning Objects (LOs) is relatively new for the educationists especially from the developing countries like Pakistan. The term LO has been coined in the field of computing and is not native to computing rather the educationists (Ip, Morrison, & Currie, 2001). HEIs of the developed countries are developing these LOs for 3 decades. Later on these LOs are then adopted by the developing countries like Pakistan, but it is not easy for Pakistani HEIs to adopt LOs due to shortage of

ICT experts, poor accessibility of ICT infrastructure, high development cost of LOs and the gap between teaching and learning communities (Khattak, 2010).

Impact: The HEIs of Pakistan need to develop the LOs in their local environment in accordance to the localized needs and existing ICT infrastructure. This will have a positive impact on the implementation and promotion of e-learning.

4.2.2 Lack of Instructional Design Process

For the development of software, various process models have been proposed e.g. SDLC, RUP, Incremental, Spiral, Agile methods etc. These process models can be applied in different scenarios depending upon the software requirements, development time and budgetary constraints. Unfortunately there is no specific process model defined which covers the instructional design process or development process of LOs in localized environment.

Impact: There is a dire need of a unified LOs development process on which both the software engineer and the educationist should agree. This issue had also been highlighted by (Barbosa & Maldonado, 2006) that there exist a need of systematic procedures to develop the quality educational products. As there is no process model proposed for the development of LOs so this is also creating hindrances in successful implementation of e-learning.

4.2.3 Lack of Instructional Designers

The design of a product has a profound effect on the quality of the product. Poor design may lead to a low quality product. The main role of the instructional designer is to design of the course contents in a manner which should fulfill the

course learning outcomes and also should enhance the learning of the learner. According to (Ivergård & Hunt, 2005) effective designing of e-learning course is a challenge for learners and e-learning providers.

Impact: Adequate resource person are providing their services to AIOU, VU and other HEIs in the field of instructional design. But they do not have proper expertise and skills in designing the courses in electronic format (Iqbal & Ahmed, 2010). This leads to poor designing of the LOs which hamper the effective learning of the learners.

4.2.4 Lack of Software Quality Assessment Process

The precise measurement of quality is a challenge. The software developers and academicians are part of the team to measure the quality of e-learning system. A lot of efforts have been expended in developing software engineering standards by the experienced software engineers and academicians (Tuohey, 2002). But there is still no agreement on the standard model for the evaluation and assessment of quality of e-learning systems (Chua & Dyson, 2004). Formal frameworks do not exist for evaluating the quality of the e-system and the contents of the e-learning products. It is urged by (Babu, 2005) that developing a quality assurance mechanism is the need of the hour as e-learning managers need an assurance of the quality of tools such as Learning Management System (LMS) and Content Management System (CMS). These tools enable organizations not only to administer their educational resources but also to support their traditional education and distance education (Al-Busaidi & Al-Shihi, 2012).

Impact: So far that a quality model or a framework is required that helps the developers and educators of HEIs of Pakistan in assuring and assessing the quality of their e-learning systems. Absence of a quality model results in the poor quality of e-learning systems, which is creating hindrance in successful adoption and implementation of e-learning systems.

4.2.5 Bandwidth

Implementation of successful e-learning environment is a dream without sufficient bandwidth. HEC has facilitated Pakistani HEIs with the high speed internet but students from the urban and rural both are suffering with this problem outside the campuses. Slow speed of internet, busy internet lines, load of traffic on international highway in the peak hours are effecting e-learning (Akar, Öztürk, Tunc, & Wiethoff, 2004; Hiltz, 1997; Rourke & Anderson, 2002; Wong, 2007). If some students logon to access course from their institution over the slow speed internet and unreliable networks, it will take longer time for browsing and loading the web pages. The heavy use of visual objects make the web complicated to a greater extent (Harper & Chen, 2012) and if the course contains these visual or multimedia material, it takes significantly longer time to load or may be the dis-connectivity due to technical hitches (Mason & Rennie, 2004) which results in the demotivation of the learners to be registered in e-learning.

Impact: Bandwidth is one of the most important barrier in promoting e-learning (Homan & Macpherson, 2005). Learners avoid to get registered in e-learning courses due to this problem in Pakistan.

4.2.6 Accessibility of Internet Broadband

There is no doubt internet technology has removed the constraints of time and distance for both teachers and learners. Broadband is more than a communication technology, it is an economic way to be online with the economic world. But in developing countries like Pakistan, access of internet broadband is one of the major hindrances in promoting e-learning. Learners of the remote and rural areas have the same requirements of broadband access as of the learners of urban and semi-urban areas. Moreover, high speed network access makes it possible to perform distance oriented applications and services like e-learning (Mason & Rennie, 2004). The Internet subscriber population is 2.4 million with less than 30,000 DSL subscribers across the Pakistan. The entire broadband population is 2,101,315 (PTA, 2012). Table 4.1, shows the average annual growth rate of broadband subscribers is approximately 127% for the last five years.

Impact: A lot of efforts are still required to provide broadband access to the learners of remote areas, so that they may not leave their places for the sake of higher education.

Table 4.1: ICT Statistics of Pakistan (PTA, 2012)

Year	No. of Subscribers
2006-07	45,153
2007-08	168,082
2008-09	413,809
2009-10	900,648
2010-11	1,491,491
2011-12	2,101,315

4.2.7 Power Failure

Successful implication and execution of e-learning requires an un-interrupted supply of electric power. Almost all communication equipment needs continuous and steady supply of power to operate. Unfortunately, Pakistan is in the crisis of power generation for the last 8 years. According to Sangi (2008), the cost of maintaining reliable power supply must be considered while switching to e-learning environment.

Impact: This issue is creating major hindrance in the successful implementation and adoption of e-learning system in Pakistan.

4.2.8 Lack of ICT Enabled Students

Success in the world of e-learning demands a new way of literacy and expertise from students (Oliver, 2001). Prior knowledge of computing is essential for the students before enrolling in the e-learning course. Beside prior knowledge, the use of computers in classrooms for the education purpose is still low (Watson, 2006).

Impact: Currently in the Pakistani HEIs, there are many students who are not capable to support their studies and research with the latest ICT. Dream of e-learning cannot be achieved until unless these learners are provided proper training to operate and to get maximum utilization from ICT.

4.2.9 Practical Arrangements for Practical Oriented Course

Some subjects like Physics, Chemistry, Biology, Sports, and Engineering etc. require intense laboratory work while studying. Testing and implementation of theoretical knowledge is only possible through laboratory learning. There is a need

of arrangements to be made for the practical in the laboratory in order to cope with the successful adoption of e-learning system.

Impact: It seems difficult to ensure that the learner has performed the entire necessary practical in the laboratory before taking the examination of that course. This issue has a negative impact in successful adoption of e-learning especially for the practical oriented courses.

4.2.10 Cost of Mobile Internet

In Pakistan, use of mobile phone is gaining attention regardless of the age and socio-economic norms. Penetration of mobiles in Pakistan has approached to 60.39% by the end of fiscal year 2012, which is 5.8% growth over the fiscal year 2011 (PTA, 2012) as illustrated in Figure 4.2. Increase of cell phone subscribers as compared to the computer users can easily be perceived from Table 4.2. With the growth of telecom and mobile industry these mobiles phones are more than a simple phone. They have now become smart phone. These smart phones have the capabilities as of computers had a few years back (Wains & Mahmood, 2008). Furthermore we can enjoy using MSOffice, Acrobat on these mobile phone devices as well. Learning can be happened anytime and anywhere irrespective of the permanent internet connection.

Table 4.2: Key indicators (Wains & Mahmood, 2008)

	Penetration/100 People	**Year**
TV	8.17	2003
Radio	7.26	2003
Computers	0.52	2005
Cell Phones	37.58	2007

Impact: According to the annual report of PTA (2012), there are 120.15 million subscribers of cell phone in Pakistan. These cell phones or smart phones can be used in the remote areas of Pakistan, where landline broadband is not accessible. But due to high cost of accessing mobile internet is becoming an obstacle in successful adoption of e-learning.

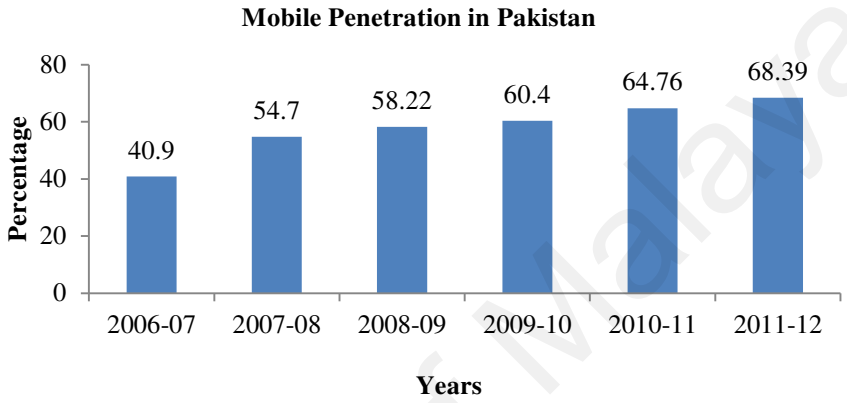


Figure 4.2: Mobile penetration in Pakistan (PTA, 2012)

4.2.11 Lack of ICT Enabled Teachers

There is lack of qualified and trained faculty members in the HEIs of Pakistan. Whereas HEIs are facing extreme shortage of the ICT enabled teachers. It is argued by Carr (1999) that lack of ICT skill is one of the barriers for the promotion of e-learning. Moreover shifting from the traditional teaching environment to e-learning environment is difficult for the teachers because they are used to and comfortable with the old traditional teaching environment (Wong, 2007). They need to revise their course and teaching material from hard mode to electronic mode. Quite large number teacher in the HEIs are not familiar even with the usage of the necessary software for the producing the course material and moreover they also do

not want to change their teaching style (Levy, 2003). As teachers are not ICT enabled so they often under-estimate e-learning that it is same as of face-to face teaching (Palloff & Pratt, 2000). It is required to elevate the teacher's training for utilizing ICT (Põldoja et al., 2012), i.e. teachers should know that how they can improve the quality of their students' and their own work. Hence the basic ICT literacy skills are considered essential for the effective and meaningful learning (Nawaz & Khan, 2012).

Impact: The course contents are still not refined due to the shortage of skilled teacher. This seriously hampers the quality of course contents and this leads to reduce the learning of the learners. This is creating difficulties in successful adoption of e-learning in Pakistan.

4.2.12 Lack of interest of faculty

Instructors are the key personnel in delivering knowledge, skill and education. Their interest is considered as a prime factor for the success of teaching and learning. Faculty members of formal public sector universities are not keen in developing the e-learning environment. As e-learning shifts from teaching centered to learners centered. This paradigm shift has challenged the traditional banking concept of learning, in which teacher plays an active role in education. Traditionalists cannot support e-learning as it goes against their basic educational assumptions (Forman et al., 2002).

Impact: It is not possible to implement and adopt e-learning environment in Pakistan, without the interest of faculty members. The lack of interest of faculty is creating obstacle in successful adoption of e-learning in Pakistan.

4.2.13 Lack of resources

Due to continuous reduction in the education spending in Pakistan, HEIs are facing extreme shortage of funds and resources. AIOU is striving hard to meet the growing needs of learners of e-learning. VU is still having most of the material in the form of video tapes only. The other formal universities of Pakistan are still does not have such minimum resources to executing their e-learning programs. These formal universities are operating in both traditional and distance learning modes simultaneously.

Impact: Huge funding is required to facilitate the formal universities in order to make them capable of developing their own e-learning resources at local level. Shortage of adequate funding is critically preventing these universities to switch to this mode of learning.

4.2.14 Socio-Cultural Norms

Approximately 40% of the total population is young and under 19 years of age, which indicates that Pakistan has relatively young human resource. More than 300 different languages are spoken in the various regions of the country, but English has adopted as an official language for education, industry and commerce. (Unicef, 2011). People of remote areas and especially from the provinces of Baluchistan, KPK and Gilgit-Baltistan do not like their females to move from their places to urban areas for the sake of education. Education of female in these areas is also banned on the basis of religion as well (Latif, 2011).

Impact: This factor is also hampering the education of learners especially females of these provinces of Pakistan. If e-learning environment is successfully

implemented, then learners from the remote areas of Pakistan will be able to get education with in their social and cultural constraints.

4.2.15 Literacy Rate

According to Pakistan Social and Living Standards Measurement in a latest survey 2012-13 that the overall literacy rate of the population (10 years and above) is 60 percent (male: 71% and female: 48%) which is 2 percent higher than the previous year (i.e. 58 percent in 2011-12) (Finance, 2014). However, according to other sources including educational experts have claimed that the overall literacy rate as about 26 per cent, urging that the higher figures of literacy rate also include people who are able to read and/or write a little more than their signature (Latif, 2011).

Impact: Lower literacy rate is creating an obstacle in promoting e-learning in Pakistan. As people are not literate so they cannot understand the significance of the e-learning. Hence, learners either are not willing to adopt e-learning or hesitate to rely on ICT for their education.

4.2.16 Lack of Formal Implementation Process

Institutional visions, long-term aims, goals, establish procedures and standards are necessary for the successful implementation of the e-learning system. It depends upon HEIs that how much these institutions enforce their policies to achieve their goals and how these institutions utilise their existing resources for the successful implement and execution of e-learning system (Masoumi & Lindström, 2012).

Impact: This issue is creating hamper in the successful implementation of e-learning system in Pakistani HEIs, as still there is need to set clear goals and develop standardise procedures to meet the increasing demand of e-learning in Pakistan. Moreover, political factor is also influencing the HEIs in adopting and implementing e-learning in the country.

4.2.17 Software Interface Design

It is important to consider whether the adopted e-learning environment (LMS, CMS etc.) supports the learning model and the level of learners. Moreover, the software incorporated Human-Computer Interaction issues while designing, in other words the adopted e-learning environment is easy to use even for those learners with minimum understanding of English. Moreover, it is also suggested by most of the researches that the adopted software should meet the local culture and languages (A. S. Andersson & Grönlund, 2009).

Impact: Pakistan is among the most illiterate countries within South Asia (Nawaz, 2012). Due to this it is required to develop such software interface that supports the localized language(s). This facilitates the learners even with the lower literacy. This issue is acting as barrier in the adoption and promotion of e-learning in the country. If the HEIs of Pakistan like AIOU and VU start developing e-learning software systems with localized languages and culture, this will promote the e-learning acceptance countrywide.

4.2.18 Borrowed e-learning models

Most of the developing countries are utilizing e-learning models which have been proposed by the developed nations. Hence, it is not possible to get the desired

results from the adopted models due to contextual and cultural differences (Masoumi, 2010; Nawaz, 2012).

Impact: As developing countries facing challenges which are different in nature from developed world (Bhuasiri et al., 2012). Moreover, there is variation in structure capital of developing and developed countries. Therefore, it is crucial for the developing countries like Pakistan to develop the localized e-learning models to get maximum advantage from this lifelong learning. This issue is creating hindrance in the promotion of e-learning in the country.

4.2.19 Access to latest computers

E-learning needs that learners can have access to the computers at all the time, whether in their organization or at home. This requires adequate computers, and computer labs with supportive working environment. In developing countries like Pakistan it is difficult for every learner to have a personal computer at home (I. A. Qureshi et al., 2012) due to low income and poverty. Unequal access to computer mediated learning also reflects inequality not only among the developed and developing countries, but also discrimination amongst the socio-economic groups within a society (Curran, 2001) .

Impact: The goal of adopting and promoting e-learning cannot be achieved until all learners are given equal access to the latest computers or computing environment. This unequal access of computers is a serious challenge to the acceptance of e-learning in the country.

4.2.20 Lack of Institutional Leadership

The direction and the roadmap of the any HEIs towards integration of e-learning depend upon the capabilities and vision of the institutional leadership of the HEI. A careful consideration of the underlying pedagogy is crucial before the implementation of e-learning environment. It is the privilege of the institutional leaders to ensure that the appropriate approach is adopted for the implementation of e-learning system (Govindasamy, 2001).

Impact: There is lack of leadership and broader vision of the people indulges in senior positions of the education system of Pakistan. This is considered to be one of the most important barriers to the adoption of e-learning in the country (Mapuva, 2009).

4.2.21 Change in university structure

By the integration of ICT in education, it becomes important to re-align the university structures and a paradigm shift in pedagogical approaches (Mapuva, 2009). The structural changes of HEIs has experienced for the last decade, in order to plan for the induction of ICT initiatives. It is urged by Scott (2000) that current institutional structure is not robust to incorporate with the facilities offered by e-learning approach.

Impact: Heavy investment is required to re-align the structures of HEIs of Pakistan. Poor economic situation of Pakistan is hampering in re-structuring the HEIs to utilize the potential of integrating ICT in education system of the country. This issue has negative impact on the adoption of e-learning in Pakistan.

4.2.22 Role of teacher and student

As teachers and learners are two of the major stakeholders of education system. Teaching and learning activities cannot be taken place without the interest of these two stakeholders. Both plays vital and critical role for the successful adoption and promotion of learning culture. Hence, their attitude towards adoption of e-learning system is crucial. Attitudes can appear to be one of the major challenges for the adoption of e-learning if not addressed properly (A. Andersson, 2008; Gammill & Newman, 2005)

Impact: As teachers consider e-learning as a challenge to their traditional teaching and learning approach so the attitude of teachers towards e-learning adoption is passive rather active. This challenge can impact positively on the adoption of e-learning, if a campaign is launched for teachers and students for the awareness of e-learning adoption. Moreover, computer training to the faculty members is also vital so that they motivate the learners to get enroll in e-learning.

4.2.23 Support for students

E-learning is fundamentally different from traditional class room teaching where support is given in term of face-to-face discussion and/or question answer session. Support from the teacher or other related staff (including IT-support) to the students will not only enhance the learning but also produce better results (A. S. Andersson & Grönlund, 2009).

Impact: This issue can impact positively, if proper support is provided to learners. Learners in HEIs of the country are not much aware of utilizing latest information and communication technologies; hence they needs sound technological

support from teachers and other IT-staff. Moreover, as learners might feel isolated and not part of the learning community without the presence of teacher or other class mates, which is essential for learning and collaboration (Hrastinski, 2008).

4.2.24 Support for Teachers

Various supports are expected by teachers to be involved actively in e-learning settings. Motivation and commitment of the teachers towards e-learning will be enhanced when they feel the level and nature of support from their institutions (A. S. Andersson & Grönlund, 2009). The support can be technical or training that enables them to use ICTs for lecture delivery with confidence. Other supports might be moral, financial and assistance.

Impact: There is lack of interest of faculty in implementing and promoting e-learning due to various reasons like unawareness of using latest digital technologies and shifting of learning from teacher centered to learner centered (Farid, Ahmad, Niaz, et al., 2015). Therefore, unavailability of support for teachers is acting as one of the major barriers in adoption of e-learning environment. Teachers can be motivated to take interest in e-learning adoption by educating and training them about the benefits of using digital technologies for teaching and learning.

4.2.25 E-Learning Environment

Learning environment is a determinant factor for the adoption of e-learning. A good learning environment is vital for the provision of an effective learning experience. As e-learning environment facilitates learners with an enhanced learning experience using digital technologies which support learners to secure better grades in their studies than those studying in traditional environment (Holley, 2002).

Impact: Creation of an effective leaning environment is crucial in order to implement e-learning in the country (Mapuva, 2009). This can be possible only when we educate faculty as ICT enabled. Hence, this issue is also creating obstacle in implementation of e-learning in the country.

4.2.26 Learning Style

Numerous learning styles exist to perform teaching and learning activities. These learning styles include spatial, aural, verbal, physical, logical, social and solitary. The ultimate goal of the learning style is to achieve academic success. Learning styles vary from learner to learner and are composed of multidimensional preferences for elements within environmental, emotional, biological, sociological, psychological and physiological strands (Abidin et al., 2011; Terregrossa, Englander, & Wang, 2009) that learning style vary from learner to learner due to certain reasons like biological and psychological variations. Therefore, it is vital for learners to be aware that which learning style is appropriate for their learning goals.

Impact: Selection of an appropriate learning style can enhance their learning capabilities. This issue also hampering the implementation of e-learning as learners is not aware that which learning style suits to their personality.

4.3 Extracting critical challenges

In order to identify state-of-the-art e-learning challenges, an open ended survey instrument (Appendix-A) of potential challenges have been formulated after reviewing more than 70 published research papers, articles, case studies from various well renowned journals and conferences. Open-ended survey is considered to be less

bias as compared to its counterpart, which may limit experts' opinion (Hasson et al., 2000). The survey has carried out with fifty-two (52) experts from different public sector universities to identify the most important and crucial challenges in the context of HEIs of Pakistan. These experts have been requested to rate the challenges in each dimension using five-point Likert scale from unimportant (=1) to most important (=5). The participants have further requested to add any of the critical issue or challenge in appropriate dimension, which is in their opinion is missing but is crucial for the localized environment. Once the experts had completed, the survey instruments have obtained for further analysis to filter the relevant challenges following the process similar to that of (Tam & Tummala, 2001). Forty-three (43) responses received for the response rate of 82%. Data has been analyzed using spread sheet software in terms of percentage and mean values, which reveal seventeen challenges. Scale value assigned to each of the five responses was as;

Level of Agreement	**Scale Values**
Most Important (MI)	5
Important (I)	4
Normal (N)	3
Least Important (LI)	2
Un-Important (UI)	1

$$Mean \quad Score = \sum \left(F_{MI} \times 5 + F_I \times 4 + F_N \times 3 + F_{LI} \times 2 \times F_{UI} \times 1 \right) / N \qquad (3.4)$$

4.3.1 Data Reduction Tool

The method of factor analysis is applied to filter the exhaustive list of e-learning challenges and for the prioritization purposes AHP method has been deployed. It is understood that the process of pair-wise comparison becomes difficult and time consuming, if the number of factors is large. Hence, in order to

overcome this problem, factor analysis, cut-off-value or some similar method is required to reduce the number of factors. Numerous variations in the method of factor analysis can easily be perceived from the literature (Tam & Tummala, 2001; Vizcaíno, García, Villar, Piattini, & Portillo, 2013).

The results of survey are summarized in Table 4.3; the mean value has been calculated of each factor and is arranged in descending order with respect to their mean values. The cutoff value has been calculated by taking the mean of max-mean (Table 4.3: 3.77) and min-mean (Table 4.3: 2.40) values to filter the list of identified challenges with respect to the localized environment. The cutoff value of 3.08 is used to identify the relevant challenges whose mean value is greater than or equal to 3.08. The challenges having mean value less than 3.08 are not considered as crucial in the opinion of experts. The reduced list of challenges is further used to prioritize using AHP method.

Table 4.3: E-learning challenges with mean values

Challenges	Responses	Level of Agreement					Mean
		5	4	3	2	1	
Power failure	Frequency	14	13	11	2	3	3.77
	%	33	30	25	5	7	
Lack of resources	Frequency	10	20	6	5	2	3.72
	%	23	46	14	12	5	
Lack ICT enabled teachers	Frequency	6	23	10	3	1	3.70
	%	14	53	23	7	2	
Software interface design	Frequency	8	22	6	4	3	3.65
	%	19	51	14	9	7	
Lack of SQA process	Frequency	8	23	3	7	2	3.65
	%	19	53	7	16	5	
Lack of LOs in local language	Frequency	7	22	6	7	1	3.63
	%	16	51	14	16	2	
Cost of mobile internet	Frequency	4	24	11	3	1	3.63
	%	9	56	25	7	2	

Literacy rate	Frequency	7	20	11	2	3	3.60
	%	16	46	25	5	7	
Lack of interest of Faculty	Frequency	4	19	12	6	2	3.40
	%	9	44	28	14	5	
Socio-Cultural Norms	Frequency	5	15	17	4	2	3.40
	%	12	35	39	9	5	
Lack ICT enabled students	Frequency	5	13	19	5	1	3.37
	%	12	30	44	12	2	
Lack of instructional design process	Frequency	2	14	24	3	0	3.35
	%	5	33	56	7	0	
Accessibility of Internet broadband	Frequency	6	19	6	8	4	3.35
	%	14	44	14	19	9	
Borrowed e-learning models	Frequency	4	15	17	6	1	3.35
	%	9	35	39	14	2	
Bandwidth	Frequency	3	18	14	6	2	3.33
	%	7	42	33	14	5	
Lack of formal implementation process	Frequency	1	18	18	6	0	3.33
	%	5	42	42	14	0	
Practical arrangements	Frequency	3	16	12	7	5	3.12
	%	7	37	28	16	12	
Learning style	Frequency	5	13	3	20	2	2.98
	%	12	30	7	46	5	
Access to latest computers	Frequency	4	9	11	16	3	2.88
	%	9	21	25	37	7	
Lack of instructional designer	Frequency	2	13	15	4	9	2.88
	%	5	30	35	9		
E-learning environment	Frequency	4	5	18	13	3	2.86
	%	9	12	42	30	7	
Role of teacher and student	Frequency	4	6	15	16	2	2.86
	%	9	14	35	37	5	
Support for students	Frequency	1	7	15	18	3	2.63
	%	2	16	35	42	7	
Change in universities structure	Frequency	2	2	26	3	10	2.60
	%	5	5	60	7	23	
Support for teachers	Frequency	2	7	10	16	8	2.51
	%	5	16	23	37	19	
Lack of leadership	Frequency	6	1	11	11	14	2.40
	%	14	2	25	25	33	

4.4 Categorization of Identified Challenges

Identified e-learning challenges have been categorized into five major dimensions based on the experiences, observations and opinions of researchers from existing literature (Abdellatief, 2011; Farid, Ahmad, Niaz, et al., 2015; Olsina et al.,

2001; Sanjay Kumar Dubey, 2012; H.M. Selim, 2007). The derived five dimensions of e-learning challenges are software, technical, institutional, personal and cultural as illustrated in Figure 4.3. Whereas description of each of the derived dimension is delineates in Section 4.5.

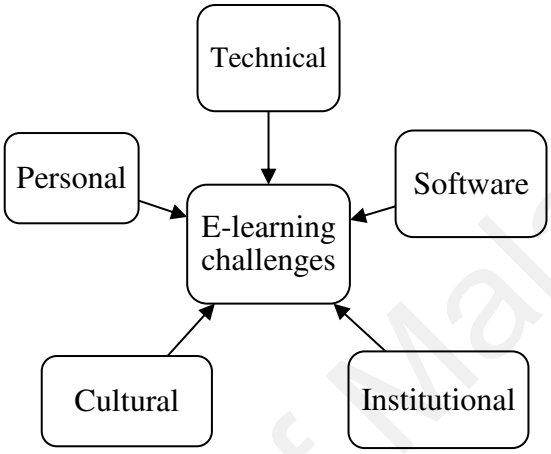


Figure 4.3: Categories of e-learning challenges

4.5 Hierarchy of Identified Challenges

There exist several methods which can be utilized to categorize the e-learning challenges. Multivariate or multi criteria techniques can be applied, however, these techniques do not integrate the preference structure of the decision maker (Salmeron & Herrero, 2005). On the other hand AHP method facilitates the decision makers or managers in a fashion so that managers are capable to express their individual preferences. However, this methodology is more suitable when the decision maker has no clear preferences over the diverse elements (Rodriguez-Repiso, Setchi, & Salmeron, 2007).

4.5.1 Procedure

AHP has been proposed by Saaty (Saaty, 1977, 1980; Saaty & Vargas, 1994). It is a powerful and flexible process used to make decision to develop priorities amongst different attributes. It allows decision makers to evaluate the relative weight of multiple criteria (or multiple options) against given criteria in an intuitive fashion. It helps decision makers with both qualitative and quantitative data for the decision making, as the decision makers can easily distinguish that which criterion is more important than others. The decision makers perform simple pairwise comparison judgments (A is more important than B). As the decision makers feel comfortable convenient using pairwise comparison form of input data. Saaty has developed a reliable method of transforming such pairwise comparisons into a set of numbers expressing the relative priority of each of the criteria. AHP has been broadly used to reflect the importance or weight of each component (criterion) associated to priorities (Macharis, Springael, De Brucker, & Verbeke, 2004; Zahedi, 1986). Moreover, AHP technique as a decision making tool can accommodate model revisions and simulations through sensitivity analysis (Forgionne, Kohli, & Jennings, 2002; Lirn, Thanopoulou, Beynon, & Beresford, 2004). The success of the AHP as a practical and reliable method is highlighted by its extensive application in the past two decades (Mardle, Pascoe, & Herrero, 2004). The basic procedure to carry out the AHP method comprises on the following steps (Salmeron & Herrero, 2005);

a) The complex decision problem is required to be decomposed into a hierarchy of interrelated elements (issues in this case).

b) Data is to be collected using pairwise comparisons of former elements (issues) and the attribute's weights have to be computed using the Eigen value method in each level.

c) The weights of categories (dimensions) have to be calculated.

Data has been collected by sending AHP questionnaire (Appendix-B) to our sampled e-learning experts. Forty-seven participants responded for a response rate of 90%. Three responses have been removed due to high inconsistency ratio; however the rest (forty-four) of the responses has reached the consistency ratio. Table 4.4 illustrates that software dimension (0.5020) has emerged as the most important dimension for the promotion of e-learning in Pakistani HEIs. However the personal dimension (0.0320) has given the least importance by respondents for the implementation of e-learning. The overall weights and the ranking of the dimensions are illustrated in Table 4.4.

Table 4.4: AHP weights and dimension rankings

Dimensions	Weights	Ranks
Software	0.5020	1
Technical	0.1050	3
Institution	0.2310	2
Personal	0.0320	5
Cultural	0.1310	4

Local weights of each critical challenge along with associated rank in the respective dimension are depicted in Table 4.5. Whereas, the global weight of each critical challenge along with related rank is illustrated in Table 4.6, which shows that software interface design (0.234434), lack of software quality assurance process (0.234434), literacy rate (0.101918), bandwidth (0.096600) and borrowed e-learning

model (0.091707) are considered the top five influential challenges in the promotion of e-learning in HEIs of Pakistan.

Table 4.5: AHP local weights and ranks of e-learning challenges

Challenges	Weights (Local)	Rank (Local)
Software interface design	0.4670	1
Lack of ID Process	0.0670	3
Lack of SQ assessment process	0.4670	2
Bandwidth	0.0920	4
Accessibility of internet broadband	0.1050	3
Cost of mobile internet	0.1290	2
Power failure	0.6740	1
Practical arrangement for practical oriented course	0.0370	4
Lack of resources	0.3800	2
Lack of formal implementation process	0.1860	3
Borrowed e-learning models	0.3970	1
Lack of interest of faculty	0.7690	1
Lack of ICT enabled teacher	0.1040	3
Lack of ICT enabled students	0.1270	2
Lack of LOs in local language	0.1110	2
Socio-cultural norms	0.1110	3
Literacy rate	0.7780	1

4.6 Hierarchal Model

A hierarchal model based on AHP for the e-learning challenges has been developed as illustrated in Figure 4.4. The findings reveal that major stakeholders of the e-learning systems are facing at least seventeen crucial challenges from five dimensions influencing the implementation and promotion of e-learning in the country. These dimensions include software, technical, institutional, personal and cultural. Most of the dimensions (except the software dimension) have already been identified by different researchers in different contexts of e-learning (Bhuasiri et al., 2012; Dillon & Gunawardena, 1995; Isik, 2008; Leidner & Jarvenpaa, 1993; H.M.

Selim, 2007). The emergence of five dimensions is significant as this is consistent with the state-of-the-art e-learning literature, which reported almost similar number of dimensions in different context of e-learning. Now we discuss each dimension separately.

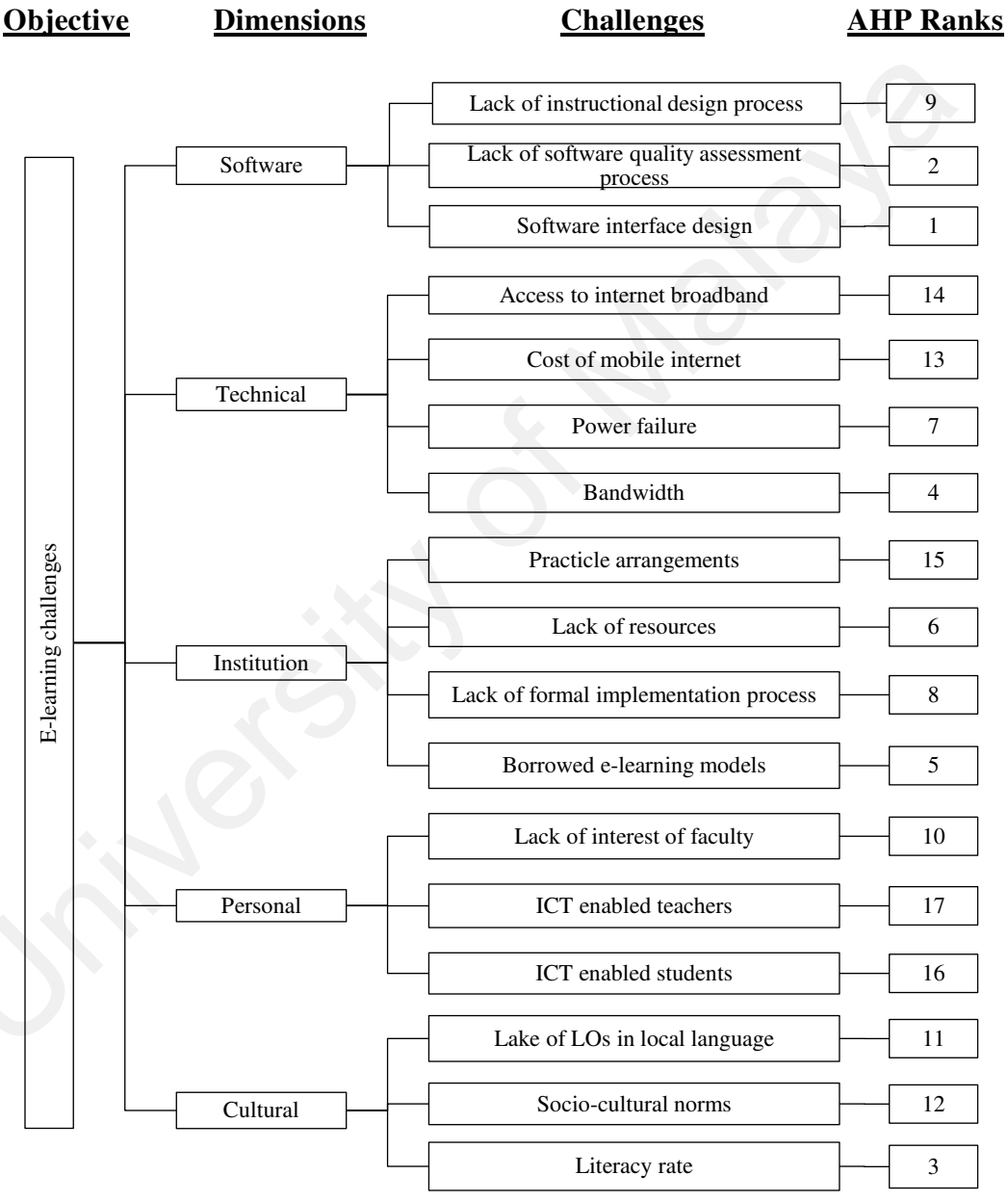


Figure 4.4: Hierarchical model for e-learning challenges

a) Software

To the best of our knowledge the dimension of Software has never been considered as a dimension in the context of e-learning challenges. It is a very important dimension, which deals with the development of an e-learning product or learning objects (L.Os.). The e-learning product is a piece of software that is developed for learning purposes such as a small simulation, static html-pages, power point slide or online courses (Berger & Rockmann, 2006; Khattak, 2010). The software dimension also deals with the development of the e-learning platforms that could be a LMS or a CMS.

Table 4.6: AHP global weights and ranks of e-learning challenges

Challenges	Weights (Global)	Ranks (Global)
Software Interface design	0.234434	1
Lack of SQ assessment process	0.234434	2
Literacy rate	0.101918	3
Bandwidth	0.096600	4
Borrowed e-learning models	0.091707	5
Lack of resources	0.087780	6
Power failure	0.070770	7
Lack of formal implementation process	0.042966	8
Lack of ID Process	0.033634	9
Lack of interest of faculty	0.024608	10
Lack of LOs in local language	0.014541	11
Socio-cultural norms	0.014541	12
Cost of mobile internet	0.013545	13
Accessibility of internet broadband	0.011025	14
Practical arrangement for practical oriented course	0.008547	15
Lack of ICT enabled students	0.004064	16
Lack of ICT enabled teacher	0.003328	17

It has also been observed that the development process of an e-learning product has many similarities with the software development process (Barbosa & Maldonado, 2006). Moreover the process model used to develop an e-learning product is identical to traditional Water Fall Software Development Process Model (Punyabukkana, Sowanwanichakul, & Suchato, 2006). The perceived challenges like lack of quality assurance process for e-products, lack of instructional design process and poor software interface are having influence towards software engineering or software development discipline. Hence, these challenges are grouped in the category of software.

b) Technical

Integration of ICT in education has raised many challenges for the HEIs and learners. One of the common challenge regarding technical category is the accessibility of technology for attaining knowledge and information for learners (A. S. Andersson & Grönlund, 2009; Mapuva, 2009). Accessibility to technology includes access to sufficient bandwidth (Homan & Macpherson, 2005), high speed internet broadband (Mason & Rennie, 2004) and the cost of accessing these technologies as well. Beside all these challenges, the most important and major challenge is the steady supply of electric power. Successful implication and execution of e-learning requires an un-interrupted supply of electric power as almost all communication equipment needs continuous and steady supply of power to operate. Hence, the challenges related to ICT like bandwidth, internet broadband, mobile internet, latest computers, power failure and cost of accessing these technologies are grouped in technical dimension.

c) Institution

Institutional visions, long-term aims, establish procedures, standards and e-learning models are necessary for the successful implementation of the e-learning system. It depends upon HEIs that how much these institutions enforce their policies and how these institutions utilise their existing resources for the successful implementation and execution of e-learning system (Masoumi & Lindström, 2012). Most often, developing countries adopted e-learning models, tools or technologies from developed countries (Maher Alghali, 2014; Nawaz, 2012). As the challenges facing by HEIs of the developing countries to implement and promote e-learning are different from those of developed countries (Bhuasiri et al., 2012). The requirements of organizations vary from one another consequently one model is not suitable for all due to environmental and cultural differences. Hence, it is required for the HEIs to formulate the localized standards in order to promote e-learning in the country. The challenges of lack of resources, practical arrangements for practical oriented courses and lack of formal implementation process are related to the institutions providing e-learning facilities hence are grouped in the dimension of institution.

d) Personal

The interest and willingness of faculty members and learners is considered as a prime factor for the success of teaching and learning. HEIs are facing extreme shortage of the ICT enabled teachers and learners. Lack of ICT skills is one of the challenges for the e-learning adoption and promotion (Carr, 1999; Croxall & Cummings, 2000; Watson, 2006). Faculty members of formal public sector universities are not keen in developing the e-learning environment. Moreover shifting from the traditional teaching environment to e-learning environment is

difficult for the teachers and learners as they are used to and comfortable with the old traditional teaching environment (Wong, 2007). In addition, e-learning shifts from teaching centered to learners centered. This paradigm shift has challenged the traditional banking concept of learning, in which teacher plays an active role in education. Traditionalists cannot support e-learning as it goes against their basic educational assumptions (Forman et al., 2002). The issues associated with learners and teachers are placed in the dimension of personal.

e) Cultural

It is crucial to consider the impact of cultural and social issues before integrating ICT in education (I. A. Qureshi et al., 2012). Approximately 40% of the total population is young and under 19 years of age, which indicates that Pakistan has relatively young human resource. More than 300 different languages are spoken in the various regions of the country, but English has adopted as an official language for education, industry and commerce (Unicef, 2011). According to Pakistan Social and Living Standards Measurement in a latest survey 2012-13 that the overall literacy rate of the population (10 years and above) is 60 percent which is 2 percent higher than the previous year (Finance, 2014). People of remote areas and especially from the provinces of Baluchistan, KPK and Gilgit-Baltistan do not like their females to move from their places to urban areas for the sake of education due to their cultural and social constraints. Moreover, education of female in these areas is also banned on the basis of religion as well (Latif, 2011). Moreover, HEIs of the developed countries are developing e-products for the last 3 decades. Later on these products are then adopted by the developing countries (Khattak, 2010), but due to lower literacy rate and lack of e-products in local language the learners are hesitant

to get enroll in e-learning courses. The challenge of language barrier is also reported in literature in different studies (Anuwar & Datuk, 2004; Hvorecký, Manažmentu, & Cesta, 2005; Nawaz, 2012; Shraim & Khlaif, 2010). The challenges like socio-cultural norms, literacy rate and lack of LOs in local language are associated with cultural norms of Pakistan; hence grouped in the cultural dimension.

4.7 Summary

This chapter presented the impact of identified e-learning challenges in the implementation and promotion of e-learning in developing countries like Pakistan. These challenges include lack of instructional designers, lack of localized learning objects, and lack of instructional design process, software interface, power supply, literacy rate, borrowed e-learning models and socio-cultural norms. Factor analysis method was applied in order to filter the most crucial challenges in context of localized e-learning environment of developing countries such as Pakistan. Filtered challenges were then classified into respective dimensions such as software, technical, institutional, personal and cultural. A hierarchal model was also developed to understand the significance of challenges with respect to their importance and criticality. One of the top critical challenges i.e. lack of software quality assessment process for e-learning system is formulated as research focus for this dissertation. The next chapter defines further investigation of the research focus by conducting a Systematic Literature Review to a) collect all the existing quality models and frameworks of e-learning systems and b) identify the potential quality characteristics for e-learning systems.

CHAPTER 5: E-LEARNING QUALITY MODELS AND FRAMEWORKS: A SYSTEMATIC LITERATURE REVIEW

This chapter discusses the Systematic Literature Review (SLR) that is conducted to explore the state-of-the-art quality models and frameworks developed for the quality assessment, assurance or evaluation of the e-learning systems. The aim of SLR is to meet research objectives 2 and 3 by exploring the literature to find out the answers to the research questions RQ2.1, RQ2.2 and RQ3.1. Furthermore, this chapter also delineates the procedure and pre-defined review protocol adopted to conduct this SLR.

5.1 Procedure

The SLR has carried out according to the procedure described by Kitchenham and Charters (2007). The whole process of review is divided into the following activities including planning, realization and reporting, each of which consists of several steps. Three researchers are involved in the review and it takes 6 months to complete. Flow of conducting the SLR is depicted in Figure 5.1. However, an outline of the various activities performed during this SLR is illustrated Table 5.1, mentioning the planning, realization and reporting processes on a time scale and the outcomes produced as part of each process.

The planning activity is concerned with developing the review protocol as well as deciding how the researchers should interact and work to conduct the SLR. In addition, improvements in the review process are shown. The overview of the realization activity reflects the steps taken in the process of conducting the systematic review. The reporting activity shows how the pilot report and the final

report evolved. Finally, the outcomes are described in terms of protocols, forms and also how the number of relevant papers changed as the systematic review process progressed.

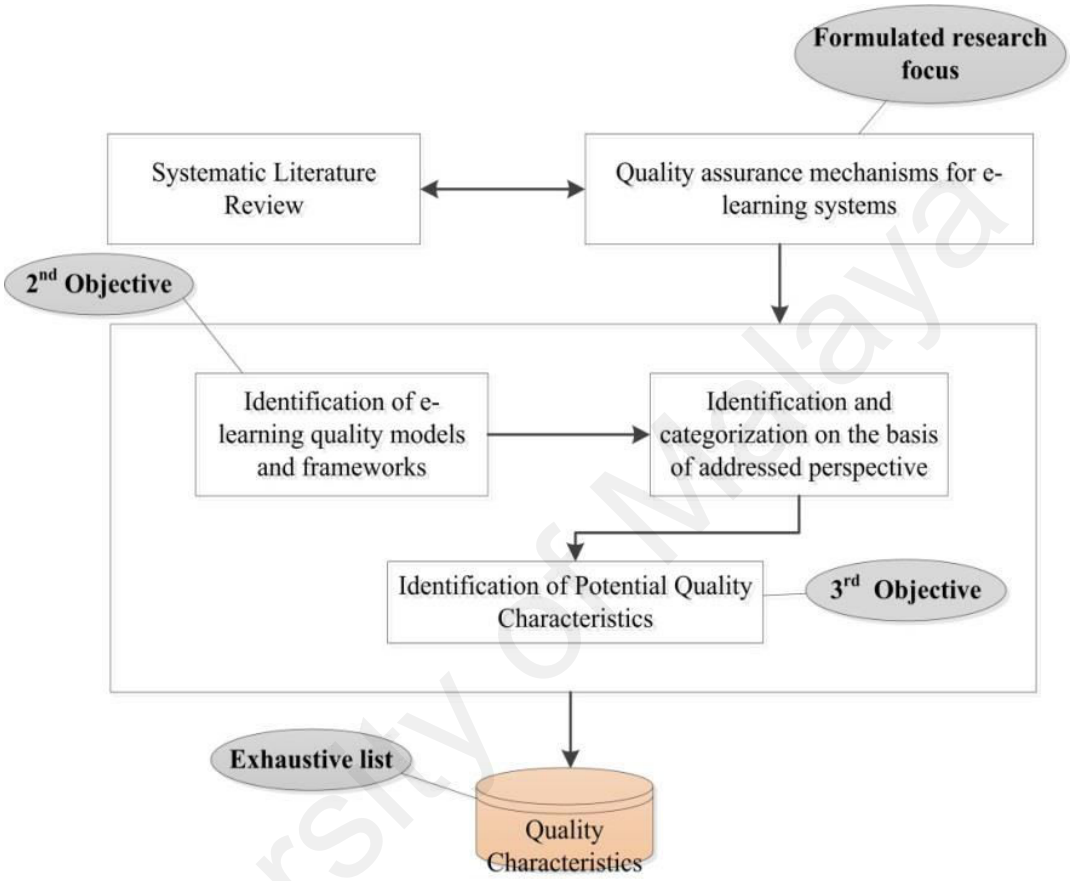


Figure 5.1: Flow of SLR

First of all we have developed protocol for our SLR that leads us to conduct the review by following the controlled procedure. The protocol included research questions, search strategy, evaluation strategy, inclusion/exclusion criteria, data extraction form and synthesis methods. The protocol was revisited and refined in iterations after piloting each of the related review steps.

Table 5.1: Activities in SLR

	Planning	Realization	Reporting	Outcomes
October 2013	Protocol development	• Searches • Data retrieval • Selection upon titles • Consensus meetings		• Review protocol • Repository with articles • Initial screening of articles • Draft: data extraction form
November 2013		• Selection upon abstracts & Keywords • Revisit reviewed papers (in pairs)		• Primary studies screened • Screened articles based on abstracts and keywords • 173 papers reviewed
December 2013	Conducting the review	• Revisit reviewed papers (in pairs) • Pilot: data extraction: 40 papers (in pairs)		• Definition dictionary • Refine: Data extraction form
January 2014	Process improvement	• Revisited reviewed papers (in pairs) • Consensus meeting		• 43 papers reviewed
February 2014		• Revisited review papers • Disagreement resolution • Consensus meeting • Data synthesis	Initial report	• 16 papers left
March 2014			Final Report	

5.2 Search Strategy

To identify the potential research papers, we executed the devised search string on selected source repositories. Consequently, this helps in answering the formulated research questions. The boundaries of the SLR have adjusted during data retrieval. First of all, the keyword(s) for the search have selected. These aim at finding the studies regarding quality assurance models and frameworks of e-learning systems. Performing searches on full text ensured that, even though the terminology in e-learning is rather diverse, the papers related to quality assurance activities of e-learning has certainly (in most cases) contain at least one of the terms that has used. The studies have been chosen if they reported on the quality assurance, assessment or evaluation activities of e-learning system. Search strategy and inclusion exclusion criteria are depicted in Table 5.2.

Following Search string has been devised for automated search within prescribed databases.

((quality) AND (assurance OR assessment OR evaluate*) AND (model OR framework) AND ("electronic learning" OR "e-learning" OR "eLearning" OR "Web-based learning"))

Table 5.2: Search strategy

Search databases:	IEEE Xplore ACM Digital Library Springer Link Science Direct Web of Knowledge Emerald
Search Items:	Journal articles Conference papers Chapters
Language:	English
Publication period:	Since 2000 to February 2014
Inclusion criteria	I1. Studies which are published since year 2001 will be included. I2. Studies which are published in English will be included. I3. Studies which contain the keywords i.e. "web-based e-learning system" OR "quality of online systems" OR "quality model for electronic learning" OR "synchronous and/or asynchronous learning" in title will be included. I4. Studies proposing the quality model/framework for the quality of e-learning system will be included.
Exclusion criteria	E1. Studies which are published before year 2001 will be excluded. E2. The studies with mismatch abstracts will be excluded. E3. The paper in which we cannot access its full text. E4. If there is more than one paper for the same study, the ones which are less complete will be excluded. E5. Those articles/studies that do not contain the relevant material which led our survey towards the answers of our research questions will also be excluded.

Papers published before 2000 were not included in the search. The main motivation for this was due to the fact that paradigm of e-learning is considered as a 21st century trend and that studies conducted after 2000 are more relevant than studies being 10 years old or more. The outcome of a search generally results in a rather high proportion of papers, which later are examined as being out of scope. Therefore it is not sufficient to use the search strings as the exclusive criteria for

deciding whether to include or exclude a specific paper. Thus, the researchers collectively decided the limits based consensus. This is also one reason why it is crucial that several researchers are involved in a systematic review. Table 5.3 illustrates the initial results obtained from automated search;

Table 5.3: Initial results from automated search

Database	Results
Science Direct	832
IEEE XPLORE	266
ACM	195
Emerald Insight	35
Springer Link	1974
Web of Science	367

5.3 Study Selection Procedure

The objective of the study selection process is to identify the papers relevant for the objectives of the systematic review in accordance with the agreed scope. The search strings, as discussed in section 5.2, are quite broad and hence it is expected that not all studies identified would make it to the final phase in the selection process as discussed above.

5.4 Data Extraction Process

Targeted databases have been divided amongst the researchers. A repository of 3669 articles had identified based on the formulated search strings. Duplicate articles were excluded manually which result in 3713 articles in the repository.

Applying title based screening (first screening), 583 articles were left in the repository having the keyword(s) of quality model or framework, e-learning quality and/or online learning quality.

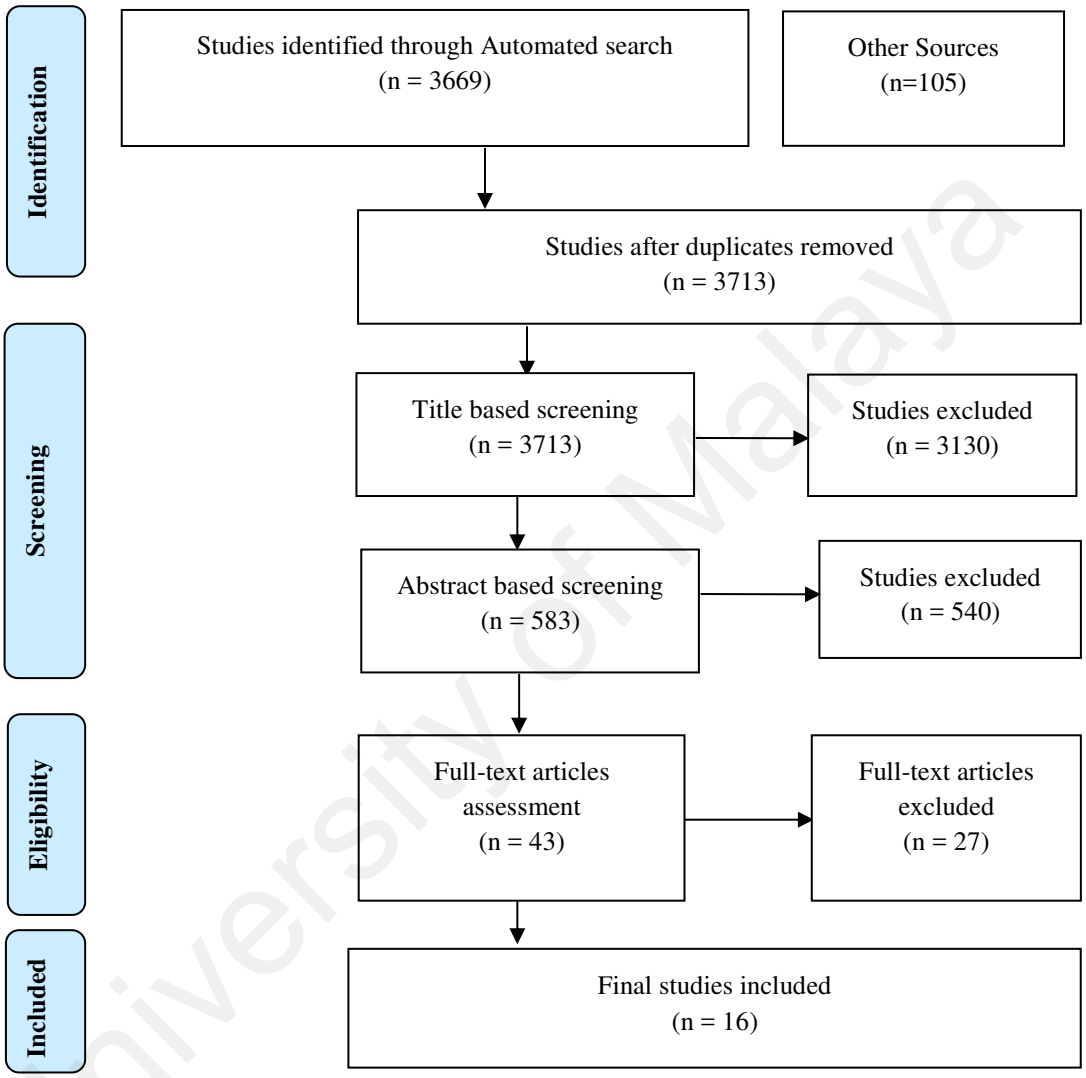


Figure 5.2: Flow of selection of papers

A consensus meeting of all the researchers has been held in order to exclude papers on the basis of abstracts. The articles do not have any contribution towards the proposition of quality model or framework for e-learning system have excluded from the repository during third screening resulting in only 43 articles in the

repository. These articles have divided amongst the participating researchers. To avoid any biasness, each article has been reviewed by two researchers resulted in 16 such studies (RQ2.1) that fulfilling the inclusion criteria. Flow of selection of studies is illustrated in Figure 5.2 and Table 5.4 is illustrating the whole process of inclusion and exclusion criteria in various steps.

Table 5.4: Inclusion and exclusion criteria

No.	Relevance analysis phase	Involvement	Inclusion criteria	Papers left	Description of the process
1.	Selection of studies based on the search	The three researchers	– only English – date of publication: 2000 to February 2014 – only published works – contains the search strings	5367+105 = 5472 (105 from other sources)	Initial searches on targeted databases. Each researcher has searched two databases each. Other sources has also used to identify papers
2.	Checking duplication	All researchers with assigned databases	Removing duplicates	4853	Removing duplicates on the basis of titles. All researchers participated.
2.	Screening: exclusion upon titles	All researcher	not editorials, prefaces, discussions, comments, summaries of tutorials, workshops, panels	438	The studies have not contained our keywords, were excluded.
3.	Screening: exclusion upon abstracts	All researchers	quality model/framework -e-learning aspect	173	Those studies have been excluded if their abstracts had not contained any statement about e-learning quality.

Table 5.4 (contd.): Inclusion and exclusion criteria

No.	Relevance analysis phase	Involvement	Inclusion criteria	Papers left	Description of the process
4.	Consensus meeting	All researchers	Main focus on the quality assurance frameworks/ models of e-learning systems	43	If the main theme and focus of the study is not about the quality assurance framework/model for the e-learning system, have also excluded.
5.	Relevance analysis: exclusion upon full text	All researchers	– presence/proposition of quality model or framework in the paper – (only one inclusion for studies with the same results reported multiple times) – Sufficient focus on quality assurance of e-learning systems.	16	Each study read by two researchers to avoid any biasness or misunderstanding. The Studies which had not evidence of proposing quality model/framework for e-learning system, also excluded.

5.5 Data Synthesis

In order to answer the research questions as discussed in Section 1.3. We have analyzed the data by reviewing the papers and extracted the following data from the finally fifteen selected studies. Table 5.5 describes the data items extracted for the analyses in this review.

Table 5.5: Data items extracted from each study

No.	Item name	Description	Relevancy
D1	Year	Year of publication of the study	General overview (year wise trend)
D2	Type	Type of the study i.e. journal, conference etc.	General overview
D3	Focus	Main focus of the study i.e. educational or software (LMS, CMS etc.)	Strengths & limitations
D4	Characteristic	What characteristics, factors, attributes has addressed	RQ3.1
D5	Perspective	Which specific perspective has been focused	RQ2.2
D6	Contribution	Proposing new quality model, customizing the existing model or adopting	General overview

5.6 Results

We have identified 16 state-of-the-art e-learning quality models and frameworks to answer our research question RQ2.1. In the succeeding sections (Section 5.7 and Section 5.8), we answer the research questions RQ2.2 and RQ3.1 respectively by analyzing and synthesizing the extracted data from the selected studies. There are eight studies (50%) proposing quality models for e-learning systems addressing different characteristics of pedagogical perspective, whereas

seven studies (43%) are addressing only one specific dimension of e-learning system such as learner, user satisfaction, usability and software developers. Now we discuss our findings with respect to our research questions.

5.7 Perspectives and Dimensions of E-Learning Quality

On the basis of our SLR, we have identified that the terms perspective and dimension has been used interchangeably by different researchers. Here we use the term perspective. Two major perspectives as illustrated in Table 5.6 including pedagogical (addressing quality characteristics related to the educational issues) and software (addressing quality characteristics for the e-learning tools/environment like Learning Management System (LMS), Content Management System (CMS) etc.) for the quality models of e-learning systems have been derived on the basis of our SLR. These perspectives are details into different quality characteristics of e-learning systems. Seven studies (43%) have identified presenting quality model or framework by considering only single characteristics of pedagogical perspective of e-learning system, the importance of learner's as a characteristic for the quality of e-learning system has been highlighted by (Ehlers, 2004; Jung, 2011). However learner's (user's) satisfaction has been taken into consideration by (Padayachee et al., 2010; Shee & Wang, 2008), whereas the usability has identified as an important quality characteristic of pedagogical perspective by Ardito et al. (2006). However, the importance of the software developer's for the software perspective for the quality of e-learning system has been reported by Abdellatief (2011) and the characteristics (usability, functionality, efficiency, reliability) of an e-learning system for software perspective has been addressed by Chua and Dyson (2004) using ISO9126. Whereas Djouab and Bari (2016) proposed a quality model for e-learning system adapting

ISO9126. The authors introduced a quality characteristic of "return on investment" by customizing ISO9126. Studies proposing quality models for e-learning systems addressing different characteristics (learner, contents, instructional design, delivery, social, institutions, instructor etc.) in pedagogical perspective are ten (62%), whereas only three articles (18%) have been identified which are addressing software perspective of e-learning system addressing different software quality characteristics (functionality, efficiency, usability, accessibility etc.).

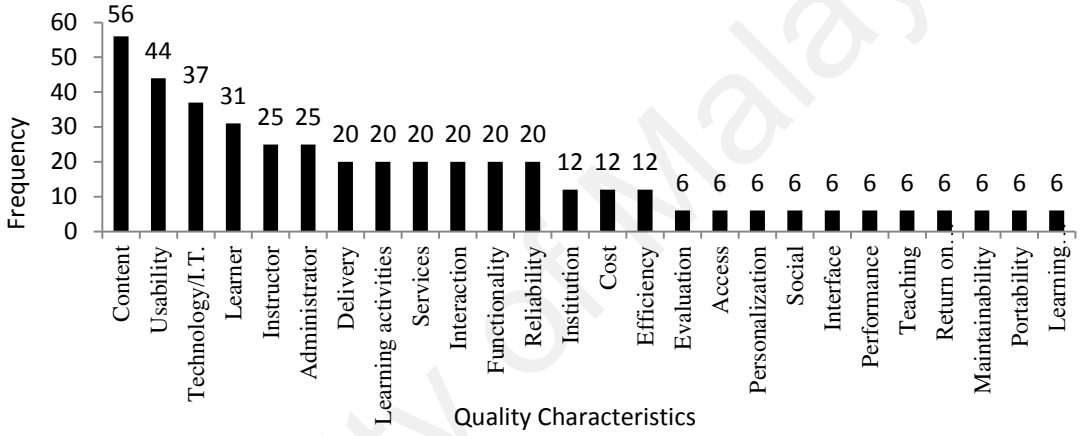


Figure 5.3: Frequency of quality characteristics

5.8 Quality Characteristics

Quality of software (traditional software systems or web-based software system like e-learning, e-commerce and etc.) can be measured and assured in terms of various quality characteristics or attributes. These characteristics are crucial for the quality assessment of the system. We have identified twenty-three different quality characteristics proposed by different researchers in their studies as important quality characteristics for the quality assessment of e-learning systems. Instructional design/content quality characteristic has been identified as the most important quality

characteristic for the e-learning systems as it has been proposed by nine studies with the frequency of 56%. Usability of the system as a quality measure has been addressed by various studies with the frequency of 46%. Frequency of different quality characteristics addressed by various studies is illustrated in Figure 5.3. Whereas details of quality characteristics addressed by various researchers has been summed up in Table 5.7.

Table 5.6: Distribution of selected studies

ID	Year	Author	Perspective	Validation	Publisher	Paper Type
S1	2002	Alistair Inglis	Pedagogy	No	Routledge	Book
S2	2002	Janet C. Moore	Pedagogy	No	Sloan Consortium	Book
S3	2004	Chua and Dyson	Software	Yes	ASCILITE	Conference
S4	2004	Ehler	Learner	No	European Journal	Journal
S5	2006	C. Ardito	Usability	Yes (Experiment)	Springer	Journal
S6	2006	Rosa Lanzilotti	Pedagogy	Yes	Edu Tech & Society	Journal
S7	2007	Lucia Blondet Baruque	Pedagogy	No	EATIS	Conference
S8	2008	Daniel Y. Shee	Learner	Yes	Elsevier	Journal
S9	2009	Jennifer Ireland	Pedagogy	No (Performed comparison with existing models)	Emerald	Journal
S10	2009	M'hammed Abdous	Pedagogy	No	Emerald	Journal
S11	2009	Sevgi Ozkan	Pedagogy	Yes	IEEE	Conference
S12	2010	Padayachee	User satisfaction	No	University of Pretoria	Journal
S13	2011	Insung Jung	Learner	Yes	Springer	Journal
S14	2011	Majdi Abdellatief	Developer	Yes	Science Publication	Journal
S15	2012	D. Masoumi	Pedagogy	No	Blackwell Pub	Journal
S16	2016	Rachida Djouab	Software	No	IJIET	Journal

Table 5.7: Summary of quality characteristics addressed by various studies

Quality Characteristics	Studies
Content	(Alastair Inglis, Joosten, & Ling, 2002),(Ehlers, 2004),(Lanzilotti, Ardito, Costabile, & De Angeli, 2006),(Baruque, Baruque, & Melo, 2007),(Shee & Wang, 2008),(Ireland, Correia, & Griffin, 2009),(Abdous, 2009),(Ozkan & Koseler, 2009), (Masoumi & Lindström, 2012)
Delivery	(Alastair Inglis et al., 2002), (Abdous, 2009)
Evaluation	(Masoumi & Lindström, 2012)
Instructor	(J. C. Moore, 2002),(Ehlers, 2004),(Ozkan & Koseler, 2009),(Masoumi & Lindström, 2012)
Institution	(Masoumi & Lindström, 2012), (Jung, 2011)
Admin	(Alastair Inglis et al., 2002),(Baruque et al., 2007),(Ireland et al., 2009),(Jung, 2011)
Learner	(Alastair Inglis et al., 2002),(J. C. Moore, 2002),(Ehlers, 2004),(Shee & Wang, 2008), (Jung, 2011)
Technology	(Ehlers, 2004),(Lanzilotti et al., 2006),(Baruque et al., 2007),(Ozkan & Koseler, 2009),(Masoumi & Lindström, 2012),(Abdellatief, 2011)
Cost	(J. C. Moore, 2002),(Ehlers, 2004)
Access	(J. C. Moore, 2002)
Learning activities	(Oliver, 2001),(J. C. Moore, 2002),(Jung, 2011; Padayachee et al., 2010), (Ardito et al., 2006)
Personalization	(Shee & Wang, 2008)
Services	(Lanzilotti et al., 2006; Padayachee et al., 2010),(Ozkan & Koseler, 2009), (Abdellatief, 2011)
Social	(Ozkan & Koseler, 2009)

Table 5.7 (contd.): Summary of quality characteristics addressed by various studies

Quality Characteristics	Studies
Interaction	(Ehlers, 2004), (Jung, 2011), (Ardito et al., 2006)
Interface	(Lanzilotti et al., 2006)
Usability	(Lanzilotti et al., 2006), (Shee & Wang, 2008), (Ireland et al., 2009), (Ozkan & Koseler, 2009), (Chua & Dyson, 2004), (Padayachee, Kotze, & van Der Merwe, 2010), (Djouab & Bari, 2016)
Performance	(Abdellatief, 2011)
Efficiency	(Chua & Dyson, 2004), (Padayachee et al., 2010), (Djouab & Bari, 2016)
Learning environment	(Ardito et al., 2006)
Teaching	(Ardito et al., 2006)
Portability	(Djouab & Bari, 2016)
Return on investment	(Djouab & Bari, 2016)
Maintainability	(Djouab & Bari, 2016)

5.9 Principal Findings of SLR

It has been observed that different researchers came up with different quality assurance and assessment mechanisms (frameworks or models) for the e-learning systems. These mechanisms vary drastically according to their geographical and institutional requirements. Most of the quality models for e-learning systems have proposed in education perspective, identifying and addressing various pedagogical issues stretching from content creation to learner assessment including contents, instructional design, delivery, social, cognitive, instructor, administration, staff, learning and institutions and so on.

Most of the models (56%) are focusing on the quality characteristic of contents and this development becomes consistent and has been perceived throughout the time frame (as depicted in Table 5.7) of our SLR. Hence, this study indicates that this content characteristic has been perceived by most research (nine studies) to be the most important characteristics to be achieved in order to have the quality of e-learning system.

Another development which has been observed in e-learning arena is the Personal Learning Environment i.e. personalization of the e-learning system. Only one (6%) of the identified studies Shee and Wang (2008) have addressed this characteristic. In future, the inclination towards personalization will likely to be observed in the quality models of e-learning systems. As learner's needs are changing and growing rapidly and e-learning institutions are required to consider the individual learner's need by providing the facility of personalization. So that learners customize their e-learning tools according to their mood. Hence, it can be expected that this characteristics will be the part of forthcoming models of e-learning systems.

It has also been perceived that most of the identified studies are not addressing the evaluation characteristic of the e-learning system. We observe that evaluation of the system in terms of the output or final product of the system is necessary for the continuous operational, improvement and viability of the system. As learners (final product) are the key stakeholder of the e-learning system, hence it is essential to evaluate the quality of learning outcome. Only one (6%) study Masoumi and Lindström (2012) has highlighted the importance of evaluation as a quality characteristic. This indicates that in future the proposed models will consider this quality characteristic for the quality assessment of the e-learning systems.

5.10 Formulation of Exhaustive List of Potential Quality Characteristics

An exhaustive list of 42 potential quality characteristics was devised. These quality characteristics were identified not only on the basis of SLR but also on the basis of experiences, observations and opinions of the researchers from the existing literature. In addition, an extended literature review was also conducted to collect the quality attributes of conventional software systems (Appendix-J). The major reasons for conducting such review were that 1) the e-learning systems are basically software systems that share some quality characteristics with conventional software systems as illustrated in Figure 5.4 and 2) some of the identified articles (Abdellatief, 2011; Chua & Dyson, 2004; Djouab & Bari, 2016; Padayachee et al., 2010) have adopted and customized software quality models like ISO9126 to measure the quality of e-learning systems.

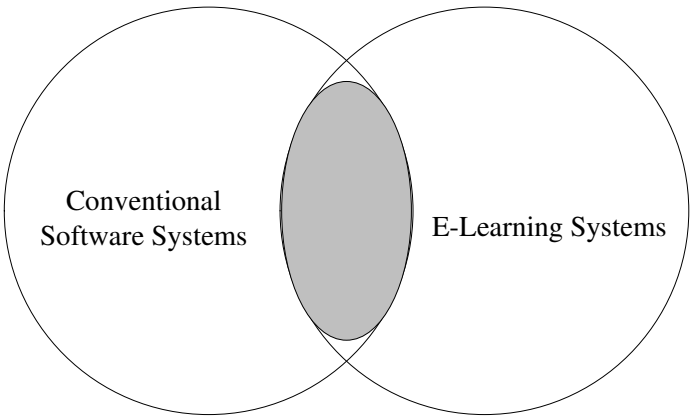


Figure 5.4: Sharing of quality characteristics

5.11 Summary

This chapter defined the process of conducting SLR in order to meet the research objective 2 and 3 by finding the answers of research questions RQ2.1, RQ2.2 and RQ3.1 respectively. Sixteen studies found proposing e-learning quality models and frameworks in different perspectives like software developers, pedagogical, user satisfaction and etc. A list of 42 identified quality characteristics was formulated on the basis of SLR, existing literature and experts' opinion. An open ended survey instrument (Appendix-C) was designed that comprised of the identified quality characteristics. A pilot test was conducted with four e-learning experts prior conducting the survey not only to check the reliability of the survey instrument but also to ensure that completeness of the list of potential quality characteristics. Various statistical tests were deployed on the data collected from survey questionnaire to extract the most crucial quality characteristics for the proposition of SQAMELS for HEIs of developing countries. Results obtained from process of statistical modeling for the development of SQAMELS are explained in next chapter.

CHAPTER 6: DATA ANALYSIS FOR MODEL DEVELOPMENT

This chapter delineates in detail about the analysis of data collected from our empirical study. An analysis of the data collected from open ended survey questionnaire accomplishes in order to conclude results. The survey questionnaire consisted of potential e-learning quality characteristics. Various statistical tests like PCA, Logistics Regression, proportion test, Kappa statistics and Chi-square have been applied on the collected data to reach the conclusion for model development. These results lead our study to achieve the research objective 4 by drawing the answers of research questions RQ4.1 and RQ4.2. This chapter has been divided into two sections. First section of this chapter represents the analysis of quantitative data captured from survey questionnaires. The second section of the chapters describes the qualitative analysis of the semi-structured interviews of the e-learning experts for the identification of quality sub-characteristics associated with quality characteristics at level one of the SQAMELS.

6.1 Quantitative Data Analysis

Different statistical test are applied to analyze the quantitative data obtained from survey questionnaire. These tests includes PCA, proportion test, Logistic Regression, Kappa Statistics and Chi-square. Results obtained from these tests led our research to develop the sustainable quality assessment model for e-learning system.

6.1.1 Demographic profile of the respondents

Demographic variables measured for this study includes name (optional), designation, organization (optional), gender, age, area of expertise and experience.

Table 6.1 illustrates the demographic profile of the participants. The sample size for this study consists of sixty-three (63) experts. However, only fifty-three (53) participants responded with the rate of 84%. Three responses were excluded due to incomplete answers. Among these, eighteen (18) were belong to academia and actively involved in the e-learning research. Eight (08) experts were from e-learning administration and twenty-one (21) were from the software development industry and. Beside these, three (03) experts were having experience of working as researchers and also involved in development of e-learning applications.

Table 6.1: Expert panel demographic profile

Demographic	Frequency	Percent
Gender:		
Male	30	60
Female	20	40
Age:		
a) 31-40	23	46
b) 41-50	18	36
c) 51-60	09	18
Qualification:		
a) Bachelors	05	10
b) Masters	31	62
c) Doctorate	14	28
Area:		
a) Academia & Research	18	36
b) Administration	08	16
c) Software Development	21	42
d) a & c	03	06
Average Experience		10 years

It is pertinent to highlight that the all of these sampled e-learning experts are holding senior positions in their organizations and are playing key role in the existing e-learning environment of their institutions.

6.1.2 Face Validity of the Instrument

Survey instrument has been sent to two e-learning experts to seek the comments and opinions to ensure the face validity of the instrument. The survey instrument has been modified by incorporating the suggestions and feedback (Appendix-D) from the researchers.

6.1.3 Reliability of the Instrument

Cronbach's Alpha is applied to test the internal validity of the survey instrument. The minimum value is considered to be >0.7. Higher values than 0.7 shows greater the reliability. Table 6.2 shows the result of this statistical test i.e. value of Cronbach's alpha is 0.943. This higher value indicating that the instrument is reliable and there exists strong consistency among the items of the instrument.

Table 6.2: Reliability statistics

Cronbach's alpha	No. of items
0.943	42

6.1.4 Extraction of the quality characteristics

Factor (quality characteristics) extraction includes determining the smallest number of factors that can be used to best represent the interrelations among the set of variables. There are a variety of approaches that can be used to identify (extract) the number of underlying factors or dimensions like Principal Component Analysis or Factor Analysis methods.

a) Principal Component Analysis

The main reason of applying PCA is to reduce the large number of components that can constitute the overall quality of e-learning systems. In other words, it is required to identify a smaller number of interpretable components that explain the maximum extent variability in the data. The exhaustive collection of quality characteristics is reduced selecting those quality characteristics crucial for the localized environment of HEIs of Pakistan. The reduction of the quality characteristics is based on the responses received from participants of the study. The characteristics extracted using PCA are depicted in scree plot (as illustrated in Figure 6.1).

In PCA, in order to visually assess which components (quality characteristic) or factors explain most of the variability in the data. A scree plot is used to display the eigenvalues associated with a component in descending order. The eigenvalues are on the y-axis and the number of components on the x-axis. According to Figure 6.1, PCA is conducted on forty-two (42) different quality characteristics of e-learning systems. This scree plot displays that twelve (12) of those characteristics explain most of the variability because the line starts to straighten after characteristics number twelve (12).

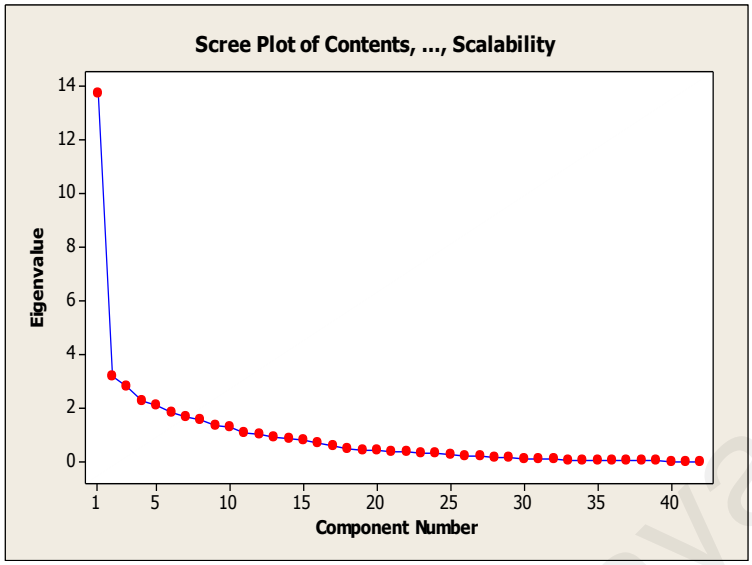


Figure 6.1: Scree plot for quality characteristics

The proportion of the extracted quality characteristics in the quality of e-learning systems is depicted in Table 6.3. The remaining characteristics (Appendix-F) explain a very small proportion of the variability and are likely unimportant.

Table 6.3: Extracted quality characteristics

No.	Predictor	Proportion
1.	Availability	0.326
2.	Performance	0.076
3.	Usability	0.066
4.	Functionality	0.054
5.	Security	0.05
6.	Reliability	0.043
7.	It-ability	0.039
8.	User interface	0.037
9.	Accessibility	0.032
10.	Accuracy	0.03
11.	Sustainability	0.026
12.	Efficiency	0.024

6.1.5 Significance of the characteristics

Logistic regression test has been applied to measure the criticality and significance of the quality characteristics extracted from PCA. A quality characteristic χ_i, is significant if the value of P≤0.05 for χ_i. Logistic regression model for the significance of characteristics is computed as;

$$Y = \frac{\exp^{\left[\beta_0 + \sum_{i=1}^{12} \beta_i x_i\right]}}{1 + \exp^{\left[\beta_0 + \sum_{i=1}^{12} \beta_i x_i\right]}} \quad (6.1)$$

In its simplest form for this case (values as summarized in Table 6.4), it is written as;

$$Y = \frac{\exp^{[\beta_0 + itabiliy + interface + accesability + availability + efficiency + functionality + reliability + security + usability + sustaibability + performance + accuracy]}}{1 + \exp^{[\beta_0 + itabiliy + interface + accesability + availability + efficiency + functionality + reliability + security + usability + sustaibability + performance + accuracy]}} \quad (6.2)$$

$$Y = \frac{\exp^{[68.683 + 11.1262 + 30.2639 + 8.001 + 12.6714 + 23.8605 + 15.0991 + 10.46145 + 20.0216 + 16.1375 + 41.7253 + 32.9846 + 13.7736]}}{1 + \exp^{[68.683 + 11.1262 + 30.2639 + 8.001 + 12.6714 + 23.8605 + 15.0991 + 10.46145 + 20.0216 + 16.1375 + 41.7253 + 32.9846 + 13.7736]}} \quad (6.3)$$

If the p-value of predictor "χ_i" (quality characteristic) ≤ 0.05, then it is considered that the quality characteristic is significant. Significant means that χ_i is crucial towards the quality of e-learning systems. According the Table 6.4, the p-values of IT-ability, Efficiency and Accuracy are greater than 0.05, which shows non-significance of the characteristic. However, the p-value of IT-ability is slightly greater than 0.05 i.e. 0.056, we can say that IT-ability is significant at 6% level of significance (having p-value ≤ 0.06). Therefore, the impact of quality characteristics

i.e. efficiency and accuracy are not crucial toward the quality assessment of e-learning systems for HEIs of Pakistan in software perspective. Hence, the results from the logistics regression support to exclude these predictors (efficiency and accuracy) from further analysis.

Table 6.4: Significance of quality characteristics

No.	Predictor	Coefficient	SE Coef	P	Odds ratio
0.	Constant	68.683	62.2	0.991	
1.	IT-ability	11.1262	2.6	0.056	2.1
2.	Interface (HCI)	30.2639	9.0	0.001	3.12
3.	Accessibility	8.00100	1.3	0.040	1.901
4.	Availability	12.6714	2.4	0.000	5.12
5.	Efficiency	23.8605	63.0	0.198	0.8031
6.	Functionality	15.0991	2.4	0.000	3.4
7.	Reliability	10.4615	2.4	0.020	2.23
8.	Security	20.0216	4.1	0.000	4.01
9.	Usability	16.1375	3.8	0.030	1.745
10	Sustainability	41.7253	4.4	0.000	3.45
11.	Performance	32.9846	1.6	0.000	4.01
12.	Accuracy	13.7736	2.8	0.060	1.21

Another way to gauge the significance or criticality of quality characteristics on overall quality of the e-learning system is to measure odd ratios. The odds ratio is one of the main ways to quantify how strongly the presence or absence of property A is associated with the presence or absence of property B in a given population. If the odds ratio of predictor is >1, then it is acceptable. The greater the value than 1 is stronger the association. According to the results from Table 6.4, the predictor availability appears to have the strongest association with the highest odds ratio i.e. 5.12. However, the predictor security and performance spring out as the stronger association with odds ratios 4.01 for both predictors. On the other hand the odds ratio

of the efficiency (0.8031) and accuracy (1.21) are near 1 and hence these factors can be negligible due to weak association. The results concluded from odd ratios supports our decision from logistic regression to retain ten characteristics (excluding efficiency and accuracy) from the selected list of quality characteristics for further analysis.

6.1.6 Impact of predictor on quality

Following conditions are to formulated in order to check whether there is any impact of the predictor on the overall quality of e-learning system or not?

1. H_0 : if $B_1 = 0$ i.e. there is no effect of the predictor on quality

   H_1: if $B_1 \neq 0$ i.e. there is effect of the predictor on quality

2. Level of significance $\alpha = 0.05$

3. Test statistics: $t = \dfrac{B^{\wedge} - B}{SE\left(B^{\wedge s}\right)}$

4. Decision;

If p-value ≤ 0.05 reject H_0 and conclude that there is effect of predictor (quality characteristic) on quality of e-learning system. According to Table 6.4, the p-value > 0.05 for only three characteristics (efficiency and accuracy) hence rejecting H_0 indicates that there is no effect of these characteristics on the quality of e-learning systems. The *t* test also validates the decision taken to exclude the quality characteristics i.e. efficiency and accuracy while retaining the ten characteristics for further analysis.

6.1.7 Goodness of fit for logistic regression model

The results deduced from logistic regression model are considered to be reliable if the model achieves the "goodness of fit" test for the said tests. In order to check that whether the logistic regression model is good to fit for the underlying data collected from e-learning experts for the proposition of e-learning quality model for HEIs of Pakistan. Following conditions are articulated for "the goodness of fit" test;

1. H_0: Model is good fit

   H_1: Model is not good fit

2. Level of significance i.e. $\alpha = 0.05$

3. Test Statistics: a) Pearson

   b) Deviance

   c) Hosmer-Lemshor

4. Decision;

According to Table 6.5, p-value > 0.05, hence H_0 is accepted and it can be concluded that the model is good fit and reliable on the basis of these tests.

Table 6.5: Goodness of fit for logistic regression

Method	DF	P
Pearson	35	1.000
Deviance	35	1.000
Hosmer-Lemeshow	8	1.000

6.1.8 Comparison of proportions

Proportion test is required to measure whether the fraction of the given samples is homogenous or not. Chi-square test is utilized to measure the proportion of samples. The chi-square test compares each of the sample values to their grand

mean. Summary of chi-square test is given in Table 6.6. Chi-square test applied on the ten (10) samples (extracted from the exhaustive list of characteristics), size of each sample is 250 with the proportion of grand mean of 0.8208. Whereas the degree of freedom (D*f*) is 10. Df equals to the number of parameters restricted under H_0 (i.e. Df is one in the case of a single proportion) (Azen & Walker, 2011).

Table 6.6: Summary of Chi-square test

Data variables	Quality
No. of samples	10
Sample size	250.0
Mean proportion	0.8208

Following conditions are formulated in order to test the proportion (p) of the quality characteristic on overall quality of the e-learning systems.

1. H_0: $p_1 = p_2 = p_3 = \ldots\ldots = p_{10}$

   H_1: Not all proportions are equal
2. Level of significance $\alpha = 0.05$
3. Test Statistics: Chi-square
4. Decision: if p-value ≤ 0.05 then reject H_0 and conclude accordingly.

Table 6.7: Chi-square test

Chi-square	D*f*	P-value
4.56	9	0.8710

According to Table 6.7, p-value > 0.05 i.e. 0.8710, hence we accept H_0, concluding that all proportions are homogenous. Since, the p-value is greater than 0.05, indicating that there are no significance differences between the quality

characteristics at the 95% or higher confidence level. This indicates that the proportion of all characteristics is homogenous according to the experts' opinion for the quality of e-learning systems of HEIs of Pakistan.

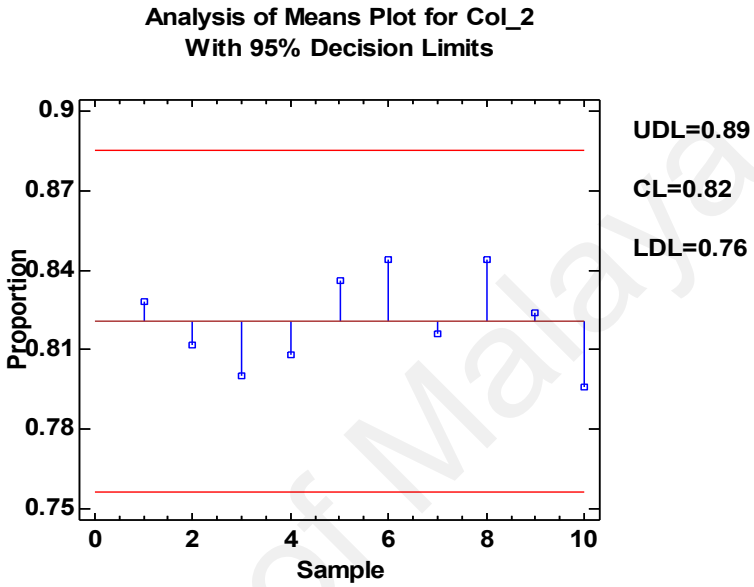


Figure 6.2: Analysis of mean plot

An analysis of means (ANOM) report is also generated that is depicted in Table 6.8, whereas, ANOM plot is also produced as illustrated in Figure 6.2 to determine which samples are significantly different from the grand mean. Figure 6.2 also shows the observed proportion for each of the 10 samples. The Upper Decision Limit (UDL) is 0.89; Lower Decision Limit (LDL) is 0.76 and the Centerline is at 0.82. According to these limits set by ANOM, no sample is beyond UDL or LDL. This indicates that there are no significant differences amongst the samples at the 95% confidence level.

Table 6.8: ANOM report

Sample	Factor	Size	Proportion *n*
1.	IT-ability	250	0.828
2.	Interface	250	0.812
3.	Accessibility	250	0.8
4.	Availability	250	0.808
5.	Functionality	250	0.836
6.	Reliability	250	0.844
7.	Security	250	0.816
8.	Usability	250	0.844
9.	Sustainability	250	0.824
10.	Performance	250	0.796

6.1.9 Level of Agreement (Inter-Rater Reliability)

Kappa analysis is used to check the inter-rater reliability agreement. There are three major stakeholders (includes academicians/researcher, administrators and software developers) of this study. Here it is important to highlight that academicians and researcher are grouped in one category, because the participant from academia are also playing their role in research as well. It is necessary to evaluate the level of agreement between the stakeholders of this study, about each quality characteristic. Now, we check inter-rater reliability between all stakeholders in pairs i.e. academician v/s administrator, academician v/s software developer and administrator v/s software developers respectively.

a) Academician v/s Administrator

Following conditions are formulated to check the inter-rater reliability agreement between the academician and administrators on the characteristics of quality assessment model for e-learning systems;

1. H_0: there is no agreement between academician and administrator

   H_1: there is agreement between academician and administrator

2. Significant value $\alpha = 0.05$
3. Test Statistics: Kappa Statistics
4. Test: if $p \leq 0.05$, then reject H_0 and conclude accordingly.

As it is depicted in Table 6.9 that p-value ≤ 0.05 i.e. $p = 0.000$ for all quality characteristics of the quality assessment model for e-learning systems. This applies to reject H_0 i.e. there is agreement between the academician and administrators of the HEIs of Pakistan about the crucial quality characteristics of e-learning system for localized environment of Pakistan.

Table 6.9: Kappa analysis for academicians and administrators

No.	Quality characteristic	Kappa	P-value
1.	IT-ability	0.75456	0.000
2.	Interface	0.85456	0.000
3.	Accessibility	0.74	0.000
4.	Functionality	0.9	0.000
5.	Reliability	0.94	0.000
6.	Security	0.8342	0.000
7.	Usability	0.7545	0.000
8.	Sustainability	0.65467	0.000
9.	Performance	0.8976	0.000
10.	Availability	0.843	0.000

b) Academician v/s Software Developer

Following conditions are devised in order to assess the level of agreement between the academician and software developers on the characteristics of quality assessment model for e-learning systems;

1. H_0: there is no agreement between academician and software developer

   H_1: there is agreement between academician and software developer

2. Significant value $\alpha = 0.05$
3. Test Statistics: Kappa Statistics
4. Test: if $p \leq 0.05$, then reject H_0 and conclude accordingly.

According to Table 6.10 the p-value for IT-ability and interface is greater than α i.e. 0.05, hence reject H_1 for quality characteristics 1 and 2 (Table 6.10). This indicates that there is no agreement between academician and software developers towards the quality characteristics IT-ability and interface. However, for the rest of the quality characteristics the p-value ≤ 0.05 i.e. p = 0.000 indicating that academician and software developer both are having agreement towards rest of the quality characteristics for the quality assessment model for e-learning systems. This applies to reject H_0 for quality characteristics 3 – 10 (Table: 6.10), i.e. there is agreement between the academician and software developers of the HEIs of Pakistan about the crucial quality characteristics of e-learning system for localized environment of Pakistan.

Table 6.10: Kappa analysis for academicians and software developers

No.	Quality characteristic	Kappa	P-value
1.	IT-ability	0.343621	0.32
2.	Interface	0.43551	0.1325
3.	Accessibility	0.72451	0.000
4.	Functionality	0.843	0.000
5.	Reliability	0.92134	0.000
6.	Security	0.88801	0.000
7.	Usability	0.6985	0.000
8.	Sustainability	0.6951	0.000
9.	Performance	0.84325	0.000
10.	Availability	0.79216	0.000

c) Software Developer v/s Administrator

For the assessment of inter-rater reliability between the stakeholder software developers and administrator on the characteristics of quality assessment model for e-learning systems, following conditions are formulated;

1. H_0: there is no agreement between academician and software developer

   H_1: there is agreement between academician and software developer
2. Significant value $\alpha = 0.05$
3. Test Statistics: Kappa Statistics
4. Test: if $p \leq 0.05$, then reject H_0 and conclude accordingly.

Table 6.11: Kappa analysis for software developers and administrators

No.	Quality characteristic	Kappa	P-value
1.	IT-ability	0.45323	0.214
2.	Interface	0.45323	0.1004
3.	Accessibility	0.800012	0.000
4.	Functionality	0.856	0.000
5.	Reliability	0.8585	0.000
6.	Security	0.92	0.000
7.	Usability	0.7982	0.000
8.	Sustainability	0.8545	0.000
9.	Performance	0.9453	0.000
10.	Availability	0.80101	0.000

According to Table 6.11 the p-value for IT-ability and interface is greater than α i.e. 0.05, hence reject H_1 for quality characteristics 1 and 2 (Table 6.11). This indicates that there is no agreement between administrator and software developer towards the quality characteristics IT-ability and interface. However, for the rest of the quality characteristics, the p-value ≤ 0.05 i.e. $p = 0.000$ representing that administrator and software developer both are having significant agreement towards rest of the quality characteristics for the quality assessment model for e-learning systems. This applies to reject H_0 for quality characteristics 3 – 10 (Table: 6.11), i.e. there is agreement between the administrator and software developer of the HEIs of Pakistan about the crucial quality characteristics of e-learning system for localized environment of Pakistan.

6.1.10 Association of Quality Characteristics

In order to determining whether there is an association, a relationship, or a dependency between two or more categorical variables. It is stated that when two categorical variables are independent of each other, reflects that these are not

associated (Azen & Walker, 2011). It is important to measure the association between the quality characteristics of the proposed model of this study. A small p-value indicates strong evidence of association (Agresti, 2013) between samples. Chi-square is applied to measure the association of each characteristic on the quality of e-learning system. Let Y represent the quality of e-learning systems, following conditions are formulated to determine the association between Y and each quality characteristic;

1. H_0: there is no association between Y and quality characteristic

   H_1: there is association between Y and quality characteristic
2. Level of association: $\alpha = 0.05$
3. Test Statistics: Chi-square which is calculated as;

$$\chi^2 = \sum_{i=1}^{k} \frac{\left(O_i - E_i\right)^2}{E_i} \tag{6.4}$$

   Where ***O*** represents the observed frequencies and ***E*** represents the expected frequencies

4. Decision: if p-value ≤ 0.05 then reject H_0 i.e. significant.

It is crystal clear from Table 6.12; the p-value for all quality characteristics is < 0.05 which lead this study to the conclusion that there is strong inclination of each of the quality characteristic towards the overall quality of e-learning systems.

Table 6.12: Pearson Chi-square test for association

No.	Characteristic	Value	Df	P-value
1.	IT-ability	16.040	4	0.003
2.	Interface	23.710	4	0.000
3.	Accessibility	26.409	3	0.000
4.	Availability	16.796	4	0.002
5.	Functionality	27.140	4	0.000
6.	Reliability	12.234	4	0.016
7.	Security	14.723	4	0.005
8.	Usability	15.487	4	0.004
9.	Sustainability	15.058	4	0.005
10.	Performance	20.201	4	0.000

6.2 Qualitative Data Analysis

The qualitative data obtained from the e-learning experts using online semi-structured interviews has been transcribed following the process of constant comparative analysis. It is a technique for examining qualitative data to yield the concepts and theories inductively (Mathers, Fox, & Hunn, 1998). This is an ongoing process in which every the conducted interview is transcribed as soon as possible before conducting the next interview. Important and interesting findings are incorporated into the next interview. Same process is repeated with each interview (Hancock et al., 1998).

It may be not essential to transcribe every interview; hence a technique called tape analysis has been applied by taking notes from the playback of the recorded interviews. This is much less time consuming as compared to transcript analysis method (Hancock et al., 1998). Every transcribed interview has reviewed critically to extract the most appropriate quality characteristics at second level of the model. Extracted quality characteristics are incorporated into the model at appropriate level

before conducting the next interview. Table 6.13 describing the major themes (quality characteristics here) supporting quotes for selecting the quality characteristics at second and third level of the model associated with quality characteristics at first level.

Table 6.13: Quotes supporting the interpretation of sub-characteristics

Themes	Supporting quotes	Interpretations
Availability	"connectivity is the most crucial quality attribute" "if online system is not connected to be available then what does it meant for? "connectivity is one of the major aims of the online systems" "fee and grade are better to be under some other category like examination or account etc. rather in availability" "online services are directly concern with the e-platform provider rather HEIs"	These examples support the interpretation of the inclusion of the quality characteristic "connectivity" at second level of "availability" and the exclusion of fee and grade under online services.
Usability	"learnability, memorability, ease of use and support of various languages are adequate to measure usability" "feedback is an important measure to assess the usability of the system" "sitemap table of contents and alphabetical index are more towards navigation"	These quotes support the folowing interpretations; a) Ease of use and friendliness are same so include one of them. b) Move undo, interactivity, navigation and aesthetics in interface design c) Site map, table of contents and index exclude from usability.
User Interface	"interface should be simple to use" "various styles should be used while designing an attractive interface" "navigability issues, aesthetics/attractiveness, undo, interactivity should be include in interface rather in usability"	These quotes support the inclusion of some sub-characteristics from usability into user interface. These factors include navigability, interactivity, attractiveness and undo facility.
Functionality	"searching, uploading, downloading and printing options adequate to measure the functionality provided by the e-system" "site map can be used instead of traceability"	These examples support to exclude traceability from functionality as site map is already been in interface design.

Accessibility	"the system should facilitate the color blind learners as well"	This quote supports that access to color blind learner should also consider along with access to learners in remote area and disable learners.
Security	"one of the major concerns of the online system is to secure it from un authorize access" "minimum indicators have been used to measure the secure the learners data" "if a learner submit his her assignment he/she must not deny from submitting his material"	These quotes support to include an additional indicator of non-repudiation under security.
Performance	"scalability is inclined towards sustainability instead of measuring the performance of a system" "rest of the indicators are sufficient to measure the performance of an e-system"	These examples affirm the inclusion of scalability under the sustainability rather performance.
Reliability	"both indicators i.e. fault tolerance and fault recovery are adequate to measure the reliability of the system" "security is another indicator used to measure the reliability of a system, however it has already been given the prime importance and identified as important characteristic at level one"	These quotes support security can be a prime concern so can be placed at first level of the model. However, fault tolerance and fault recovery are sufficient to measure the reliability of the e-system.
IT-ability	"is the e-product easy to install, un-install or configure?" "the product should remove its files from computer without affecting system and learners files when it is uninstalled"	These examples support that how easy is to monitor, install, un-install and configure the e-product on a computer.
Sustainability	"identified indicators are sufficient to address the future requirements of the HEIs of Pakistan" "modifiability is more towards the development of the e-product"	These quotes support to exclude the sub-characteristic of modifiability, as it is a concern of development level of the e-product.

6.3 Summary

This chapter discussed the results obtained from our data analysis. These results lead this study to the development of quality assessment model for the e-

learning systems for HEIs of developing countries like Pakistan. Selection of the most crucial quality characteristics from the exhaustive collection is performed on the basis of data collection using survey questionnaire method. Various statistical tests like PCA, Kappa, logistic regression and Chi-square applied in order to extract the most crucial quality characteristics for the quality assessment of e-learning system in software perspective. Twelve quality characteristics were deduced from the exhaustive list of 42 quality characteristics during data analysis using PCA and proportion tests. These quality characteristics include availability, usability, user interface, functionality, accessibility, security, performance, efficiency, reliability, IT-ability, accuracy and sustainability. Upon further investigation, two quality characteristics (efficiency and accuracy) were dropped on the basis of results obtained from logistic regression and odds ratio. Impact of each quality characteristic on the overall quality of e-learning system is measured along with the significance and proportion for the quality assessment. Analysis of means test was also applied to compare the proportion of each quality characteristic on overall quality of e-learning systems. Additionally kappa analysis was applied in order to check the inter-rater reliability of the experts. Semi-structured interviews with the experts were also conducted in order to identify and select of quality sub-characteristics associated with each quality characteristic. The semi-structured interviews were transcribed and analyzed conducting content analysis method. Outcomes from both qualitative and quantitative analysis lead this study towards the development of the sustainable quality assessment model for e-learning systems (SQAMELS). Description of the developed model along with quality characteristics, sub-characteristics and working is explained in Chapter 7.

CHAPTER 7: SUSTAINABLE QUALITY ASSESSMENT MODEL FOR E-LEARNING SYSTEMS: A SOFTWARE PERSPECTIVE

The proposed Sustainable Quality Assessment Model for E-Learning Systems (SQAMELS) from software perspective is described in this chapter. Key aspects of the proposed model are discussed in the context of HEIs of Pakistan. Brief introduction and limitations of the previously proposed frameworks and models are also discussed to elaborate the need of proposed model. Moreover, guidelines how to use this model to assess the quality of an e-learning system are also formulated in this chapter.

A theoretical or conceptual framework or model is defined as a visual or written narration of the main things to be studied in the form of key factors, variables and presumed relations between these (Miles & Huberman, 1985). On the basis of literature, there are four main sources for the construction or development of a framework and/or model. These sources include a) existing theory and prior research, b) experimental knowledge, c) exploratory and pilot research and d) experiments (Maxwell, 2012). The Systematic Literature Review (SLR) reveals that currently there are few studies that focus on the quality of e-learning system in software perspective. So, adequate literature is not available to address the challenges of e-learning systems in software perspective (especially for the developing countries like Pakistan). Due to this reason the software perspective is projected as an independent and important dimension of e-learning systems (Farid, Ahmad, Niaz, et al., 2015).

Moreover, on the basis of SLR, most of the evaluation methods adopted by various authors may be correct for the evaluation of an existing e-learning system by

analyzing usability or learners' satisfaction. On the other hand, if an institution intends to adopt an e-learning platform, what should be the selection criteria? How it can be decided? What should be the guidelines for selecting an appropriate quality e-learning platform? How administrators/decision makers determine if an e-learning system has good quality or not? Hence the model proposed in this study can facilitate the HEIs of developing countries like Pakistan to assess the quality of e-learning systems they are using or going to adopt and provide guidelines to the researchers and academicians for the quality assessment of their e-learning systems. The quality assessment model proposed here concentrates on three major aspects which includes i) system quality, ii) service quality and iii) charisma of an e-learning system. Various critical quality characteristics (like availability, security, reliability, interface design, usability, functionality and sustainability) affecting the quality of an e-learning system in software perspective are taken under consideration. These areas are supposed to constitute the basic criteria that any e-learning platform should cover more or less.

7.1 Construction of the Proposed Model

The construction of the proposed model is based on two studies. First, it is through an exploratory study (discussed in chapter 3) conducted to identify the most crucial challenges of e-learning in various dimensions and secondly, it is through the systematic literature review (as discussed in chapter 5) performed to deepen the understanding of the research focus by examining the state-of-the-art quality models and frameworks proposed for the quality of e-learning systems. Both studies contribute in the construction of quality assessment model for the localized

environment of HEIs of developing countries like Pakistan keeping software perspective in mind.

7.2 Structure of the Proposed Model

Quality attribute is a difficult element to measure but it is crucial especially for a software system with the main objective to enable it to be viable or sustainable. Quality issue is considered as one of the major issues in recent education scenario in general and for e-learning systems specifically (Williams & Jacobs, 2004). It is not possible to express the quality of e-learning system by simply setting the definition without understanding the details of the system. The term quality is a very broad and bear various dimension such as service quality, information quality and system quality (Alla, 2013). Furthermore, there are various stakeholders of e-learning systems (as discussed in section 2.6.1). There are diverse variations in the quality requirements and point of view of every stakeholder to measure the quality of e-learning system. This means that the quality depends upon the context and the interpretation of the quality attributes and the association between those attributes with in that particular situation (Al-Kilidar, Cox, & Kitchenham, 2005). Hence, it is not significant or logical to consider that one solution fits the needs of all groups.

Based on intensive literature review and experts' opinions, the quality of an e-learning system (in software perspective) can be determined by means of three major dimensions. Therefore, the structure of proposed model encompasses three major dimensions namely system quality (quality of e-platform or e-product), service quality (quality of services provided by the e-product) and charisma (attractiveness) as illustrated in Figure 7.1. These dimensions have further been subdivided into quality characteristics. The nature of each quality characteristics depends upon

certain type of operation associated with them. These operations are network, current or existing and future operations.

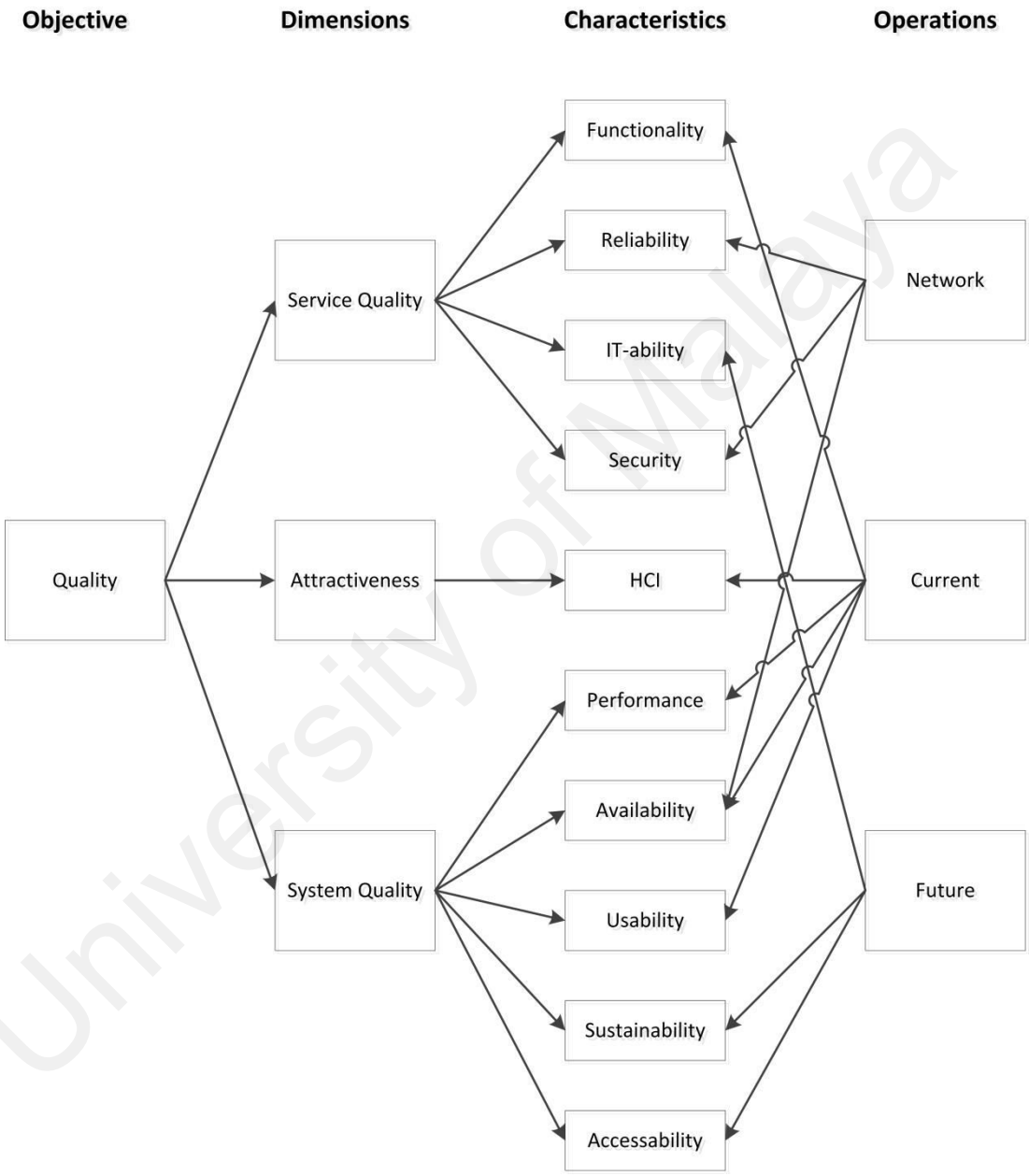


Figure 7.1: Structure of the proposed model

a) System Quality

System quality states that the perceived ability of the e-learning platform to enable learners by providing appropriate facilities likes availability, usability, performance and etc. E-learning systems are similar to general internet-based Information System (IS), and system quality remains an important measure of online learning systems (Hassanzadeh et al., 2012; J.-K. Lee & Lee, 2008; Lin, 2010). Moreover, effectiveness of an e-system cannot be attained until high level of system quality may achieve. System quality enriches the learners' satisfaction and acceptance of the e-learning arena(Alla, 2013).System quality comprises of availability of the system, usability, performance, sustainability, accessibility.

b) Service Quality

Service quality can be defined as the assessment of overall support provided to the learners by the e-learning platform. As in e-learning there is no face-to-face interaction between teachers and learners, which demand high quality of services in order to enrich the learners' satisfaction level (G.-G. Lee & Lin, 2005; Lin, 2010). Typical characteristics of service quality include functionality, reliability, security and it-ability. These quality characteristics intend to support the learners while interacting with the system.

c) Charisma

Charisma can be defined as the various aspects of the system are appealing and attractive. Moreover, the learner's belief that learning is full of fun and enjoyment (Lin, 2010). Graphical design, layout, text color scheme can enhance the

visual attractiveness and aesthetic. This as a result increased satisfaction level of the learner that glues them with the system.

7.3 Quality Characteristics of the Model

The proposed model comprises of ten key aspects of e-learning system (software perspective). It is a common belief that designing a quality assessment model means a model to compare more features and characteristics as it is considered that the model or frameworks with more features are better approaches to assess the quality. Indeed, too many features make the model complex/difficult/clumsy to utilize. Ultimately the practitioners or the administrators tend to ignore such mechanisms (models or frameworks) to use. Hence, utmost care has been taken while proposing the model by applying series of statistical tests on the data collected from empirical investigations. The purpose of applying series of statistical tests is to extract those quality characteristics that are most crucial for the localized environment of developing countries like Pakistan. Moreover, discussions with the stakeholders of the e-learning systems also help out in the proposition of the optimize quality assessment model (i.e. to cover diverse aspects of software perspective by utilizing minimum set of quality characteristics). The extracted characteristics of the proposed model are discussed one by one;

7.3.1 Availability

Availability can be explained as the degree to which a system is available and operational for use to the learners when it should be (Sanjay Kumar Dubey, 2012). Moreover, availability of the system is also refers as the extent to which the system is available for learners whenever it is required (Behkamal, Kahani, & Akbari,

2009). System availability is one of the important aspects of any e-learning system. The system is considered to be worthless if it is not available to its users twenty-four hours a day and seven days a week. E-learning is learner centered mode of learning and a learner can access e-learning system at the flexibility of his time and place. Hence, availability must be considered as one of the prime quality factors while assessing quality of an e-learning system.

7.3.2 Usability

Software usability is defined as the degree to which computer software assists a user to fulfill tasks (Storey, Phillips, Maczewski, & Wang, 2002). It is further explained by ISO 9241-11 as the degree to which a software product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use (W. ISO, 1998). Usability of an e-learning system means how much the system is usable by an ordinary learner or user. Ordinary learner can belong to numerous backgrounds and qualifications may or may not be having much knowledge of operating the computers. If the learner can learn easily to use the e-learning system for their goals (teaching and learning) which, reflects that the system is easy to use. The e-learning platform should facilitate the learner in a way that learner feels comfortable while using the system. A well-designed system, built according to a clear, well thought-out structure, will tend to be easier to learn and use than a messy one. The condition is not sufficient, of course (what is simple and clear to the designer may be difficult and obscure to users, especially if explained in designer's rather than user's terms), but it helps considerably. On the other hand one of the main reasons of the failure of e-learning systems is that the usability of most of the e-learning system is not of the high

quality (Sun et al., 2008). We believe that if a system is highly usable, it surely enhances the learning. Usability of a system has profound effect on learning of the learner specifically in the e-learning domain.

7.3.3 User Interface

E-learning systems are essentially interactive and collaborative software products (Bleimann, 2004). Hence, the role of interface is crucial in the acceptance and continuous usage of any collaborative or interactive online system. It is the front end or portal for learners to utilize the e-system. A well-designed user interface can enhance the attractiveness and increase the learner interest or intention to use the system (Law & Leung, 2000) and engage in learning experience. On the other hand, a poorly designed user interface is enough to make confuse and frustrate the learner from e-learning which may lead system to failure. Moreover, user interface assist learners by facilitating them to fully utilize the numerous functionalities provided by the e-learning system. In short, user interface plays vital role in the acceptance and intention to use the system with by meeting the learners' satisfaction. Thus in order to evaluate a software product, the concepts of Human Computer Interaction (HCI) essentially considered especially the user interface design principles must applied to e-learning systems. Therefore, following features must be considered while evaluating the user interface of any e-learning system: attractiveness, simplicity, interactivity, style issues, undo and navigation facilities.

7.3.4 Functionality

Functionality is the extent of possibilities or functions provided by a system. It is a vital characteristic while assessing the quality of an interactive or collaborative

software product. It is challenging to know how much functionality is enough for the system. There is always a stress in software industry to facilitate the learner or user with diverse range of functionalities. The pressure of providing more facilities to users is worse for commercial products, as the administrators perform a comparative review of all the features offered by competing products. The reason is to consider the product offering all crucial functionalities in order to function according to the learners' requirements. Minimum quality criteria for measuring the functionality of e-product is the presence of the features like searching (local and global), retrieving, uploading, downloading along with printing facility as well.

7.3.5 Accessibility

Accessibility refers to learner's ability to access learning materials from e-learning system (Wixom & Todd, 2005). Accessibility is one of the major advantages of computer mediated learning that deals with the extent to which online learning tool can be accessed with minimum efforts. As majority of the population is in rural areas of Pakistan hence the ultimate intention of the HEIs is to make it possible for the learners to access the system even from remote areas. Moreover, the system may be required to facilitate those learners having some sort of disability like color blind, deaf and etc. Real benefits of e-learning will be acquired only when the system is accessible for diverse categories of learners accessing from various locations (rural and/or urban) of the country. Therefore, evaluation of the e-learning system must have tendency to be accessible in remote areas and for the disable learners as well.

7.3.6 Security

It is prime and vital for all systems including software systems to be secure regardless that systems is offline or online. Security issue becomes more serious when a system is shared by multiple users. Multiple learners can access and utilize e-Learning systems by performing various tasks like uploading, downloading and/or exchanging distributed information simultaneously. This indicates that there is concentrated need of high level of security in e-learning applications (El-Khatib, Korba, Xu, & Yee, 2003). E-learning systems often permit many-to-many communication services between learners to instructors or learners to learners or learners to other systems. Hence the issues of security between learners and e-system are important to be tackled and assured. The security shield protects data from unauthorized access and assures the identity of the learners interacting with the e-learning system (Pantel, 1997).

One common way used to handle the security in e-learning systems is to provide a unique user ID and password to every learner of the system. This is not enough as a fool proof security. The security can be made tighter by creating an additional layer by providing a specific code to be entered to login to the system. Whenever the learner login to the system, a unique code (randomly generated on every login attempt) may be sent to the leaner using email ID or cell phone number (which ever preferred by the learner). The learner is now required to enter this code before proceeding to the system. Beside this system's security must be considered. Crack in system may lead to denial of services and even stop of communication.

Minimum indicators required to assure the security of an e-learning system can be verification, authentication, confidentiality, integrity and non-repudiation of

the system. These all require proper implementation of cryptography at hardware or software level. While evaluating an e-learning system, evaluators must consider at least a minimum level of security services provided by the system because fixing appropriate security issues is crucial in any e-learning system.

7.3.7 Performance

Performance is one of the dominant measures for the success of the e-learning system. Main characteristics to measure the performance of an e-learning system are response-time and throughput. It is measurement of the quality of services provided by the e-system. The principle aspect for the learners is the "responsiveness" or "good" performance of the service (Rudolf & Pirker, 2000). It is widely believed that if the system is not responding in eight seconds, the users will bail out. Bail out is the rate of the users who do not bother to wait for a function or page to be loaded within eight seconds (Zona, 1999). The response-time varies on the basis of nature of connection (broadband, dial-up or etc.). In order to measure the performance of e-system, it is necessary to consider that in the rural areas of Pakistan where the connectivity base on dial-up rather on broadband, the response time should be increased.

7.3.8 Reliability

Reliability of an e-learning system can be measured in terms of two factors including fault tolerance and recovery. Both factors should be considered crucial in order to evaluate the reliability of a system. Reliability can be defined as the ability of a software system to maintain a specified level of performance when used under specified situations (Sanjay Kumar Dubey, 2012). Reliability is an important

determinant of the quality and effectiveness of an e-learning system. If an e-learning system is not reliable, it cannot attain the learner's intention to continuous use.

7.3.9 IT-ability (Information Technology-ability)

IT-ability can be defined as the set of various issues that covers different measures related to IT. These issues include the ease of installation, un-installation, configuration of the system, operation and monitoring. Hence, while measuring the quality of an e-learning system the factors of IT-ability are also crucial to be considered.

7.3.10 Sustainability

Sustainability can be explained as the degree of the adoption of technology to endure teaching quality at the reduced costs (Dearing, 1997; Littlejohn, 2003). It can be further defined as the e-learning normative practice in which it has the capacity to meet the needs of the present and adapt to the needs of the future (Robertson, 2008). In a more sophisticated fashion, sustainability can be describes as the design and development of e-system that can be modified, updated or scaled up (scalability) utilizing minimum efforts. An e-learning system cannot meet the quality characteristic of sustainability if it does not have the capabilities to accommodate the future needs of the HEIs and learners. Moreover, a sustainable system should sustain with the rapid changing in e-learning environment. The following characteristics modifiability, extendibility, scalability and portability should be considered for the evaluation of the sustainability of an e-learning system.

The key characteristics of quality assessment model of any e-learning system are summarized in Table 7.1.

Table 7.1: Ten key aspects of SQAMELS

Characteristics	Sub-Characteristics	Sub-Sub-Characteristics
Availability	Connectivity	
Usability	Memorability	
	Ease of use	
	Consistency	
	Feedback	
	Multiple language support	
	Learnability	Understandability Guided tour
User Interface	Attractiveness	
	Simplicity	
	Style issues	
	Undo facility	
	Interactivity	
	Navigability	Site map Alphabetical index
Functionality	Searching	Local Global
	Retrieving	
	Uploading	
	Downloading	
	Printing option	
Accessibility	Access to learners in remote areas	
	Disable learners	
	Color blind	
Security	Verification	
	Authentication	
	Confidentiality	
	Integrity	
	Non repudiation	
Performance	Throughput	
	Response Time	
Reliability	Fault tolerance/recovery	
IT-ability	Monitor-ability	
	Install	
	Un install	
	Configure	
Sustainability	Extendibility	
	Scalability	
	Portability	

7.4 Utilization Approach of SQAMELS

The proposed model addresses ten key points associated to the software perspective of the e-learning system for HEIs of Pakistan. According to the opinion of experts participating in this study, the proposed characteristics are adequate to achieve the minimum level of quality assurance of e-system. However, HEIs may add or remove the criteria according to their requirements and needs.

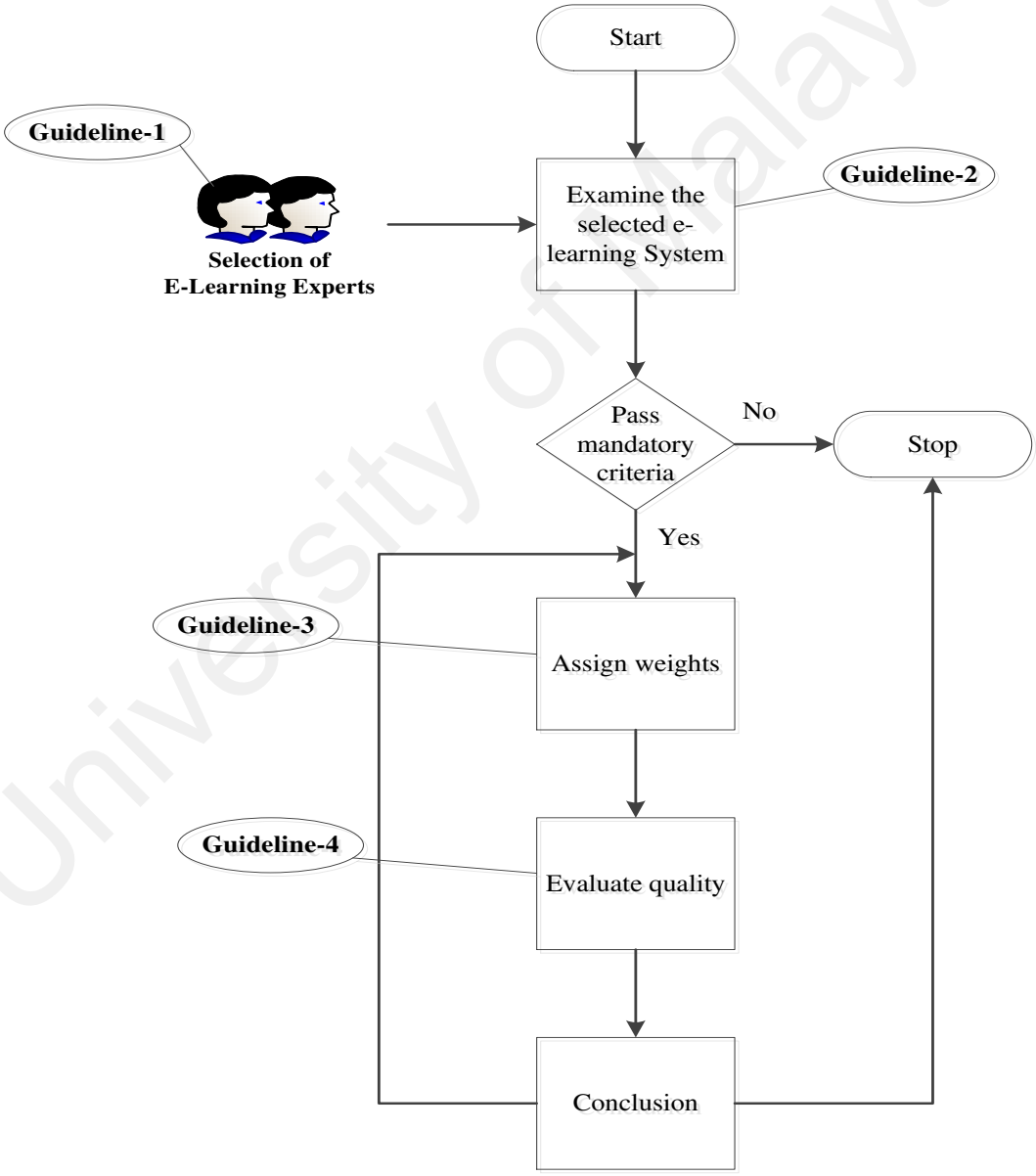


Figure 7.2: Workflow of the evaluation process

In order to utilize the SQAMELS, a process guideline is formulated which can assist administrators or responsible authorities of the HEIs of Pakistan in selecting an appropriate and suitable e-learning platform for their HEIs. There are four major guidelines involved in the assessment process to select the most appropriate e-platform. Workflow of the whole evaluation process is shown in Figure 7.2.

Guideline 1: Selection of E-learning Experts

A group of e-learning experts is required to evaluate the under consideration e-system. It will be appealing if the group of evaluators may constitute from various disciplines (like administrators, software developers, academicians etc.) of e-learning. As it has already being discussed that quality varies from stakeholder to stakeholder so it must be taken into realization that no software product can satisfy all of the stakeholders' needs at the same time. Therefore, feedback from every stakeholder is important and crucial before making decision to purchase an e-system. The final decision should be made by the competent authority on the basis of the weightage of feedback from experts.

Guideline 2: Examination of E-learning System

E-learning solutions (e-products like LMS, CMS or etc.) are expensive (Li, 2009), therefore, HEIs are required to think carefully prior to the decision of adopting an e-learning system. Before making decision, it is necessary to elaborate the rationale of adopting this paradigm of learning. Moreover, some additional issues are also required to consider before purchasing an e-platform, the list of such issues

may be longer depending on the financial conditions and objectives of the HEIs. Possible considering issues are given below:

a) Consider the level of learners (under-graduate, graduate and/or post-graduate) and domain (arts, science etc.) for which the HEI intends to adopt e-paradigm?

b) The technical and computer skills of the intended learners.

c) Geographical locations of the intended learners (rural or urban or northern areas of the country where the connectivity is difficult and bandwidth is comparatively lower).

d) IT-infrastructure of the HEI (resources to develop in house LO, instructional designers, developers, technical personnel and IT managers etc.).

e) Existing communication infrastructure provided by PTCL in the country (Internet access, broadband, wireless connectivity facilities and available bandwidth to both wired and wireless (including 3G and 4G services) connections).

f) Finally, the most important is the revenue generation after the implementation (return on investment) of the e-system.

Guideline 3: Importance and Assigning Weightage

The proposed quality assessment mode can be utilized to evaluate multiple e-learning systems simply by assigning weights to the identified quality characteristics by different stakeholders with different prioritization. For example an administrator might have given higher priority to the availability and comparatively lesser priority to the usability of the system, whereas an instructor might give higher priority to the usability and functionalities provided by the e-system as compared to the availability or security of the system. On the other hand managers may give higher priority to

security and reliability of the system as compared to any other quality characteristic. Hence, evaluators can discuss each attribute and assign weight according to the degree of the facilities (with respect to proposed model) provided by the intended system according to their importance and specific need.

Typically, it is not possible to satisfy all of the quality requirements at the same time. Hence, it is crucial to determine the weights of all quality characteristics of intended e-system. First of all, the evaluation team inspects the model and determines which characteristics are mandatory, which are missing (if any) according to specific requirement of the HEIs and which are relevant.

Let there be n quality characteristics $f_1, f_2, f_3, \ldots, f_n$ those constitutes the quality of an e-learning system. Their weights W_{imp} is based on its importance. This weight is calculated on the basis of mean values computed during statistical analysis of the empirical study conducted by e-learning experts based on survey questionnaire (Appendix-E). This weight remains fixed as it is the opinion of the respondent e-learning experts. However, characteristics at second level can be assigned weights by the evaluators according to the particular situation and specific requirements of the HEI. It is vital to keep in mind that the sum of weights of all sub-characteristics must be equal to the weight of the associated characteristic at first level. Same procedure can be applied for assigning weights to the attributes at third level (if any). So quality Q can be written as a sum of all quality characteristics according to their need and importance;

$$Q = \sum \left(W_{imp_1} \left(f_1 \right) + W_{imp_2} \left(f_2 \right) + \cdots + W_{imp_n} \left(f_n \right) \right) \tag{7.1}$$

$$\Rightarrow Q = \sum_{i=1}^{n} W_{imp_i}(f_i) \tag{7.2}$$

Guideline 4: Evaluation Criteria

According to the experts' opinion of this study, availability and security quality characteristics are mandatory for any e-learning system to be considered for its adoption. If even a single member of the evaluation team shows reservations about the extent of the mandatory criteria then the system will be rejected by assigning zero to the mandatory criterion. Hence, there is no need to proceed with the further assessment of the system.

When members of the evaluation team check the targeted e-learning system, they judge that how much the system is facilitating with respect to each of the quality characteristics of the model. In other words, to what degree the support is present in the system. Every member will assign the weight W_{eval} to each quality characteristics according to the extent of his/her satisfaction level (which is according to the need of that stakeholder) about the facility provided by the system from the viewpoints of software perspective accordingly. So overall quality is the product of the function achieved in step 3 and W_{eval},

$$Q = \frac{\sum_{i=1}^{n}\left(W_{imp}(f_i) * W_{eval}(f_i)\right)}{(5 * n)} \tag{7.3}$$

Where n is the total number of quality criteria under consideration which is 10 in this case. The value of W_{eval} ranges from 0 to 1, with 0 for not satisfied to 1 for fully satisfied. Division by 5 is used to normalize values because a maximum value

of 5 can be given to any quality characteristic according to Likert scale in empirical study.

Now we apply our defined criteria for the two scenarios in order to formulate some benchmark for the evaluation of the e-learning system. These scenarios are worst case scenario and best case scenario.

7.4.1 Scenarios

There could be two possible scenarios for the SQAMELS, one can be the best case in which all quality characteristics will be assigned maximum weight i.e. 1 and other possible scenario could be the worst case in which all quality characteristics will be assigned zero weight. Now we discuss these two scenarios by assigning maximum and minimum weights to the quality characteristics respectively.

a) Best Case Scenario

Let consider that the panel of e-learning experts is fully satisfied with the level of quality provided by e-learning systems under examination. Experts assign weights $W_{eval}(f_i) = 1$, to all quality characteristics. Putting $W_{eval}(f_i) = 1$ for all characteristics in equation (7.3).

$$Q = \frac{\left((4.04*1)+(4.22*1)+(4.06*1)+(4.18*1)+(4.00*1)+(4.08*1)+(3.98*1)+(4.22*1)+(4.14*1)+(4.12*1)\right)}{(5*10)}$$

$$Q = \frac{41.04}{50}$$

$$Q = 0.8208$$

b) Worst Case Scenario

Let consider that the panel of e-learning experts is not satisfied with the level of quality provided by e-learning systems under examination. Experts assign weights $W_{eval}(f_i) = 0$, to all quality characteristics. Putting $W_{eval}(f_i) = 0$ for all characteristics in equation (7.3).

$$Q = \frac{\left((4.04*0)+(4.22*0)+(4.06*0)+(4.18*0)+(4.00*0)+(4.08*0)+(3.98*0)+(4.22*0)+(4.14*0)+(4.12*0)\right)}{(5*10)}$$

$$Q = \frac{0}{50}$$

$$Q = 0$$

7.4.2 Threshold Values

From the above results, it can easily be concluded that the value for the overall quality Q of the e-learning system can lies within the range from 0 – 0.8208. Table 7.2 is illustrating the threshold values for our proposed model.

Table 7.2: Threshold values for the quality assessment

SQAMELS Value	Quality
0	Rejected
0.1 - 0.2052	Poor
0.206 - 0.4104	Acceptable
0.411 - 0.6156	Good
0.616 - 0.8208	Excellent

7.5 Summary

This chapter described the structure and working of the proposed model. Different dimensions like software quality, service quality and attractiveness of the model have been highlighted along with the descriptions of the quality characteristics of the model. Each dimension comprised of various quality characteristics like availability, usability, user interface, functionality, accessibility, security, performance, reliability, IT-ability and sustainability. Criteria for the quality assessment have formulated and process guidelines for the utilization of the model have been delineated. Moreover, worst case and best case scenarios are also discussed in order to provide threshold values for the quality assessment of e-learning systems. The proposed model is validated using four validation methods including reviewing the existing literature, survey questionnaire from practitioners, survey questionnaire from experts and applying the proposed model to a LMS of one of the HEIs of Pakistan.

CHAPTER 8: MODEL VALIDATION

This chapter explains the process of validation performed to evaluate SQAMELS. Various methods for the validation of the frameworks and models have been suggested in the literature (Creswell, 2013; Alistair Inglis, 2008) and particularly being used for validating the empirical research in software engineering (Easterbrook et al., 2008). These validation methods include reviewing the research literature, experts' opinion; empirical investigation, survey research, pilot projects and case studies. For this dissertation, four methods have been adopted to validate the proposed model. These methods include the review of literature, survey from practitioners (to measure the applicability of the model), survey from experts (to gauge the utility of the model) and applying the proposed model on an existing e-learning environment conducting a case study. The processes of validation lead this study to ensure the appropriateness (applicability) and usefulness (utility), ease of use and adaptability of the proposed model for the quality assessment of e-learning system for HEIs of developing countries like Pakistan.

8.1 Validation Process

The purpose of the validation process is to demonstrate that the objectives have been attained. In other words it can be stated that the process of validation is a link or connection between data and the conclusions (Bryman, 2012). It tends to describe the process as being carried out in a systematic manner and shows the transparency of the research process. Furthermore, validity in qualitative research is explained as the degree in which the conclusions match the social phenomenon to which it refers during whole process of research (Hammersley, 1990). Moreover, the process of validating the qualitative research involves self-scrutiny and constant

reflexivity (Finlay, 2002). Therefore, in order to support the applicability and utility of the SQAMELS, questionnaire based surveys have been conducted with the e-learning experts (academicians and researchers) and practitioners (developers, software engineers, managers (IT/ICT), Instructional designers). These experts and practitioners have been selected from various HEIs and software industry of Pakistan to ensure the real significance of the SQAMELS.

8.2 Validation Methods

Four methods have been deployed to validate SQAMELS as illustrated in Table 8.1. These methods include the review of literature, survey questionnaire from practitioners, survey questionnaire from experts and applying the SQAMELS on an existing e-learning environment conducting a case study.

Table 8.1: Methods used to validate SQAMELS

Review of existing literature (Section 8.2.1)	**Experts' Opinion** (Section 8.2.3)
• **Method:** a) Exploratory study b) Systematic Literature Review • **Focus:** Analysis of features of existing quality models and frameworks with SQAMELS. • **Results:** SQAMELS found adequate enough to assess the quality of e-learning systems.	• **Method:** A survey questionnaire from experts (academician and researchers) • **Analysis:** Statistical analysis • **Focus:** To gauge that SQAMELS is easy to use by HEIs to assess the quality of their e-learning system they are using or going to adopt. • **Results:** No significant difference found among the experts at the 95% confidence level.
Practitioners' Opinion (Section 8.2.2)	**Case Study** (Section 8.2.4)
• **Method:** A survey questionnaire from practitioners (software engineers, IT administrators, instructional designers, software developers)	• **Method:** Applying SQAMELS on an existing LMS of AIOU, Pakistan. • **Analysis:**

• **Analysis:** Statistical analysis • **Focus:** To evaluate that SQAMELS is appropriate to be used by HEIs for quality assessment of their e-learning systems. • **Results:** There found 95% confidence level amongst practitioners.	Analyzed data by applying formulated approach for the assessment of e-learning system. • **Focus:** To measure the quality by applying SQAMELS on an existing e-learning system. • **Results:** SQAMELS is applicable and easy to utilize.

8.2.1 Review of Literature

A strong foundation for the validation of the suitability of the proposed model can be facilitated by the existing literature (Alistair Inglis, 2008). This method involves identification of factors that affect the effectiveness with which quality is assessed. The proposed model is found adequate enough to assess the quality of any e-learning systems in software perspective and this has been validated with the help of this method (relevant existing literature). Most of the identified e-learning quality models are proposed in pedagogical perspective addressing the quality characteristics related to teaching and learning activities. Nevertheless, the quality models proposed in software perspective of e-learning systems are found deficient to address adequate set of software characteristics. A comparison of features addressed by SQAMELS with existing quality models is summarized in Table 8.2. On the basis of conducted SLR, only five studies have been identified that propose e-learning quality models in software perspective. The quality characteristics addressed by SQAMELS cover adequate aspects of software perspective as compared to existing e-learning models. These characteristics include availability, security, IT-ability, accessibility and sustainability. In order to cope with the rapidly growing requirements, the quality

characteristics such as accessibility and sustainability make SQAMELS to address the future needs. A detailed description and limitations of existing e-learning quality models and frameworks have already been delineates in Chapter 2, Sub-Section 2.4.2 to Sub-Section 2.4.3, and Chapter 5 Section 5.9.

Table 8.2: Comparison of SQAMELS with existing models in software perspective

Characteristics	(Chua & Dyson, 2004)	(Ardito et al., 2006)	(Padayachee et al., 2010)	(Abdellatief, 2011)	(Djouab & Bari, 2016)	SQAMELS
*Perspective	S	S	S	S	S	S
Technology/I.T.				X		
Return on investment					X	
Learning activities		X				
Services				X		
Interaction / Co-operation		X				
Interface						X
Functionality	X		X	X	X	X
Reliability	X		X	X	X	X
Performance				X		X
Usability	X		X		X	X
Teaching		X				
Learning Environment		X				
Efficiency	X		X		X	
Portability					X	
Maintainability					X	
Accessibility						X
Security						X
Availability						X
IT-Ability						X
Sustainability						X
*S = Software						

8.2.2 Survey Questionnaire with Practitioners

The major objective of evaluating the proposed model is to gauge whether the proposed model is applicable to be employed for assessing the quality of e-learning system adopted by the HEIs of developing countries like Pakistan. In order to achieve our objectives, method of survey questionnaire with practitioners has been applied. To be more specific, a Goal Question Metric (GQM) statement as illustrated in Table 8.3 for the evaluation has been developed. GQM is a goal-oriented approach that supports the measurement of processes and products in software engineering domain. If viewed narrowly, GQM approach may be seen as purely an approach for choosing metrics (Differding, Hoisl, & Lott, 1996).

Table 8.3: GQM statement for applicability validation

To Analyze	The proposed model
Purpose	To evaluate the applicability of the framework
From	Software perspective of e-learning systems
Context	Questionnaire based survey from e-learning experts, including administrators, DBAs, software engineers and instructional designers.
Reason	To validate the applicability of the proposed framework

This method involves three steps: selection of participants, procedure and analysis. Their detail is given below:

8.2.2.1 Participants

In order to perform applicability validation process, 15 practitioners are requested to participate in the evaluation process of proposed sustainable quality assessment model for e-learning systems. Only eight practitioners have showed their

willingness to participate in this activity. These practitioners are divided into two groups 1) e-learning developers, software engineers and instructional designers and 2) managers and directors. It is important to acknowledge that the data have been collected from practitioners who are involved actively in the development of e-learning applications, maintaining e-learning systems and performing administration of the e-learning system in various HEIs and software industry of Pakistan. Therefore, we have high confidence in the accuracy of data. A truly representative sample is not possible to accomplish and the researcher should try to remove the sample bias as much as he or she can (Niazi, Wilson, & Zowghi, 2005). Beside administrative and development responsibilities; some of the participants are actively involved in research arena as well. The average experience of the experts is around ten years. Brief profile of the participants is given in Table 8.4. The participants have been requested to fill the survey instrument in which they have requested to give their opinion about the features identified in the proposed model.

Table 8.4: Profile of the participants

No.	Position	Organization
1.	Regional Director	AIOU
2.	Principal Scientist	ICCC
3.	Director Academics	VU
4.	Director ICT	Nextbridge
5.	Senior Software Engineer	BDA
6.	ID Developers	AIOU
7.	Head (Computing & Technology)	Abasyn University
8.	Director	University of Education

8.2.2.2 Procedure

The major objective of the survey is to gain information and feedback from e-learning experts of HEIs and software industry of Pakistan in order to determine the applicability of the proposed solution for the quality assessment of e-learning systems. A survey instrument has been formulated (Appendix-G). Experts are requested to respond to the questions using five point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

8.2.2.3 Data Analysis

Data has been collected and is stored in MS Excel sheet. Later different statistical methods have been applied on the data collected to analyze different parameters.

a) Reliability Analysis

Cronbach's alpha has been applied on the collected data to measure the reliability and internal consistency. Cronbach's alpha is already explained in detail in Chapter 3, Section 3.2.4. Table 8.5 is illustrating the reliability statistics of the responses obtained from the participated experts regarding the applicability of proposed model. The value of Cronbach's alpha is 0.770 which is an acceptable reliability score (Nunnally Jum & Bernstein Ira, 1978). This value indicating that the acquired data is reliable and there exists strong consistency among the respondents towards the applicability validation of the proposed model.

Table 8.5: Reliability statistics for applicability validation

Cronbach's Alpha	No. of Items
0.770	8

b) Proportion Test

In order to assess that whether the model is fit for the applicability or not, proportion of each sample of the instrument towards the objective of the applicability validation has been calculated using Chi-square test (description of Chi-square test is already discussed in Chapter 3, Section 3.5.3). This test discovers the role of each response in the evaluation of applicability validation of the proposed model. Furthermore, this procedure examines the hypothesis that the mean proportions of the 8 samples are identical towards the applicability validation of the proposed model. Summary of chi-square test is given in Table 8.6. Chi-square test applied on all eight (8) samples and size of each sample is 8 with the proportion of grand mean of 0.859375.

Table 8.6: Summary of Chi-square test

Data variables	Quality
No. of samples	8
Sample size	8
Mean proportion	0.859375

The following conditions have been formulated in order to test the proportion (p) of the each sample for the evaluation of applicability validity of the proposed model.

a) $H_0 : p_1 = p_2 = p_3 = \ldots = p_8$

H_1: Not all proportions are equal

b) Level of significance $\alpha = 0.05$

c) Test Statistics: Chi-square

d) Decision: if p-value ≤ 0.05 then reject H_0 and conclude accordingly.

Table 8.7: Chi-square test

Chi-square	**D*f***	**P-value**
1.24	7	0.9901

The computed value of chi-square is 1.24 and the p-value > 0.05 i.e. 0.9901 as illustrated in Table 8.7. Hence H_0 is accepted, concluding that all proportions are homogenous, that is all samples are contributing towards the evaluation of applicability validation of the proposed model. Since, the p-value is greater than 0.05, indicating that there are no significance differences between the samples at the 95% or higher confidence level. This indicates that the proportion of all characteristics is homogenous according to the practitioners' opinion for the applicability validation of the quality assessment model for the e-learning systems of HEIs of Pakistan.

Table 8.8: ANOM report

Sample	**Proportion**
1	0.85
2	0.9
3	0.875
4	0.825
5	0.875
6	0.9
7	0.9
8	0.75

An analysis of means (ANOM) report is also generated that is described in Table 8.8. ANOM plot as illustrated in Figure 8.1 is also produced to determine which samples are significantly different from the grand mean.

Figure 8.1 shows the observed proportion of each sample. The Upper Decision Limit (UDL) is 1.17; Lower Decision Limit (LDL) is 0.55 and the Centerline is at 0.86. According to these limits set by ANOM, no sample is beyond UDL or LDL, which is indicating that all responses are almost identical and validating the applicability of the proposed model for the HEIs of Pakistan. Furthermore, it is also observed from Figure 8.1 that there is no significant difference amongst the samples at the 95% confidence level.

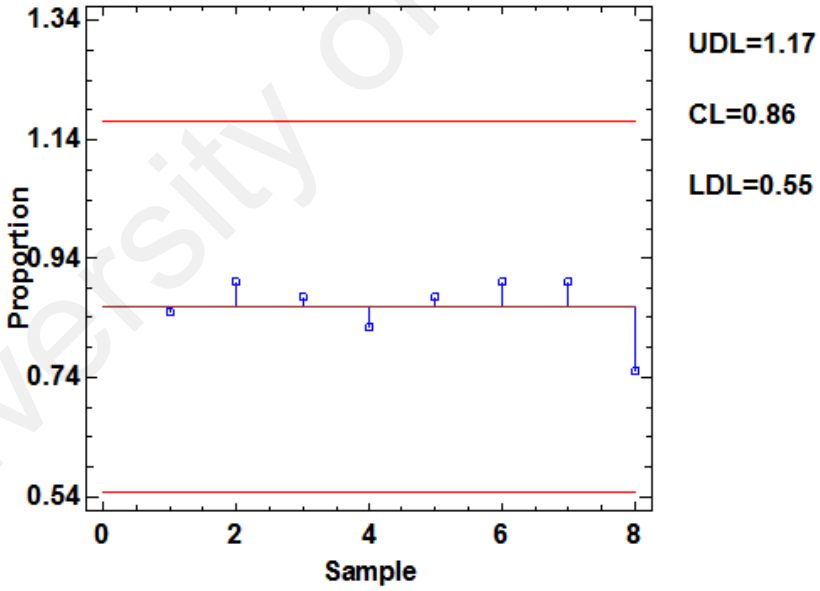


Figure 8.1: ANOM Plot for applicability

c) Comparison of Medians Test

The Kruskal-Wallis test (sometimes referred to as the Kruskal-Wallis H Test) has been deployed to gauge whether the mean response of all the experts is homogenous or not. Kruskal-Wallis test allows comparing more than two groups. Scores are converted to ranks and the mean rank for each group is compared. This is a '*between-groups*' analysis, so different people must be in each of the different groups (Pallant, 2010). Following conditions have been articulated to test that the mean response of all the respondents is homogeneous for all the items.

a) H_0: all medians are equal

   H_1: not all medians are equal

b) Significant: $\alpha \geq 0.05$

c) Test Statistics: Kruskal-Wallis

Table 8.9 illustrating the results obtained from the Kruskal-Wallis test. The p-value > 0.05 (i.e. 0.572), hence accepting H_0. This shows that the mean response of all the respondents is same or homogeneous for all the items.

Table 8.9: Kruskal-Wallis test

	N	Median	Average Rank
1	8	4.500	37.3
2	8	4.000	31.3
3	8	4.000	21.8
4	8	4.000	28.9
5	8	5.000	40.8
6	8	4.500	37.3
7	8	4.000	30.1
8	8	4.500	32.5
Overall	64		32.5

H = 5.73, DF = 7, P = 0.572

In order to gauge the respondents' response towards the appropriateness (applicable) of SQAMELS, another test Wilcoxon Signed Rank test has been applied on the collected data. Hence, following hypothesis has been formulated for the Wilcoxon Signed Rank test (median ≥ 3 versus median < 3);

a) H_0: The model is applicable according to the opinion of practitioners

   H_1: The model is not applicable according to the opinion of practitioners

b) Test Statistic: Wilcoxon Signed Rank

c) Condition: median ≥ 3 versus median < 3

We set the average value = 3 (the median of 1, 2, 3, 4, 5) because the maximum possible response is 5 if all experts are strongly agree, we can see from Table 8.10, that the median response is 4.34 i.e. sufficiently large than 3, also the Wilcoxon Signed Rank ensures that the median is greater than 3 (p = 0.995, i.e. accept the null hypothesis, i.e. > = 3 or valid). We conclude that applicability of the proposed model is validated towards its application for the HEIs of Pakistan according to the experts' responses.

Table 8.10: Wilcoxon Signed Rank Test

N	N for Test	Wilcoxon Statistic	P	Estimated Median
8	8	36.0	0.995	4.344

8.2.3 Survey Questionnaire with Experts

In order to validate the utility (usefulness) of the proposed model, it is required to gauge the usefulness of the proposed model in localized environment of HEIs of Pakistan. The e-learning experts including academicians and researchers

who already have participated in the case study (as discussed in Chapter 4) are contacted again and are requested to participate in the procedure of measuring the usefulness of the proposed model. The rationale behind contacting the same experts is because they have highlighted the challenge of the lack of quality assessment mechanism for the HEIs of Pakistan. A GQM statement for utility validation is constructed which is illustrated in Table 8.11.

Table 8.11: GQM statement for utility validation

To Analyze	The proposed model
Purpose	To evaluate the usefulness of the model
Perspective	e-learning experts from HEIs of Pakistan
Context	Questionnaire
Reason	Suggestions of practitioners help to validate the usefulness of the framework

8.2.3.1 Participants

Eighteen experts have been requested to participate in the utility validation of the proposed model. Due to their tight schedule and nature of jobs only six participants responded positively. It is vital to highlight that all participants are highly qualified and having more than 10 years of experience in the field of research and academia. Organization names associated to the respondents are illustrating in Table 8.12, however, names and designations of the participants are kept hidden intentionally.

Table 8.12: Participants' organizations

No.	Organization
1.	Allama Iqbal Open University, Islamabad
2.	Federal Urdu University of Science and Technology
3.	Virtual University of Pakistan.
4.	University of Education, Lahore, Okara campus.
5.	COMSATS, Institute of Computer Science and IT.
6.	Int. Islamic University, Islamabad

8.2.3.2 Procedure

The major objective of conducting the survey is to acquire feedback from e-learning experts in order to determine the usefulness of the proposed model for the HEIs of Pakistan. A set of questionnaires (Appendix-H) have been developed to measure the usefulness of the proposed model from the participants. The proposed model and the utilization approach to use the model (discussed in section 7.7) have been sent to the experts beforehand. The main objective of sending the related material to the experts is to make them familiar with the model and the devised weighted method for the quality assessment of e-system. The questionnaire has been divided into various perspectives on the basis of the nature of the questions. Table 8.13 is illustrating the division of questions and respective perspectives. All responses were recorded on five point Likert Scale except question no. 1 which was recorded in Yes/No fashion to get a true picture of that is there any mechanism adopted by HEIs in selecting e-learning system or not?

8.2.3.3 Data Analysis

Data has been collected from experts in order to evaluate the usefulness of the proposed model for the HEIs of Pakistan. Collected data is stored in MS Excel sheet for further processing. 85% responses were received for the perspective of

"present practices" which clearly reflects that currently HEIs do not have any mechanism to assess the quality of e-learning systems they are using or going to adopt. However, for the analysis of remaining perspectives various statistical tests have been applied to analyze the acquired data.

Table 8.13: Division of questions into respective perspectives

No.	Questionnaire	Perspective
1.	Currently, do you have any criteria or method to select an e-learning system?	Present practice
2.	How do you rate the importance of this study?	Utility
3.	The model has positive impact towards implementing e-learning practices in Pakistan.	
4.	How do you rate the complexity of the model?	Complexity
5.	Do you think it is easy to apply the model by adopting the utilization approach devised for the model?	Usability
6.	Do you think the model has the potential to be used by the relevant decision making authorities of HEIs of Pakistan?	
7.	Do you think the future requirements have been addressed by the model?	Future

a) Reliability Analysis

In order to gauge the reliability and internal consistency of the collected data, Cronbach's alpha has been employed (description of Cronbach's alpha is already discussed in Chapter 3, Section 3.2.4). Table 8.14 is illustrating the reliability statistics of the responses obtained from the participated experts to evaluate the usefulness of the proposed model. The value of Cronbach's alpha is 0.849 which is a good reliability score (Nunnally Jum & Bernstein Ira, 1978). This higher value indicating that the acquired data is reliable and there exists strong consistency among the respondents towards the utility validation of the proposed model.

Table 8.14: Reliability statistics

Cronbach's Alpha	No. of Items
0.849	6

b) Proportion Test

In order to assess that whether the model is valid for the usefulness or not, proportion of each sample of the instrument towards the objective of the utility validation has been calculated using Chi-square test. This test determines the role of each response in the evaluation of usefulness of the SQAMELS. Furthermore, this procedure checks the hypothesis that the mean proportions of all samples are identical and inclined towards the utility validity of the proposed model. Summary of Chi-square test is given in Table 8.15 mentioning the proportion of grand mean is 0.780952.

Table 8.15: Summary of Chi-square test

Data variables	Quality
No. of samples	6
Sample size	7
Mean proportion	0.780952

Following conditions have been formulated in order to test the proportion (p) of the each sample for the evaluation of utility of the proposed model.

a) $H_0 : p_1 = p_2 = p_3 = \ldots = p_6$ (all proportions are equal)

H_1: All proportions are NOT equal

b) Level of significance $\alpha = 0.05$

c) Test Statistics: Chi-square

d) Decision: if p-value ≤ 0.05 then reject H_0 and conclude accordingly.

The computed value of chi-square is 1.25 and the p-value > 0.05 i.e. 0.9403 as shown in Table 8.16. Hence we accept H_0, concluding that all proportions are homogenous. It means that all samples are contributing and inclined towards the evaluation of usefulness of the proposed model. Since, the p-value is greater than 0.05, indicating that there are no significance differences between the samples at the 95% or higher confidence level. Hence, it can be concluded that the proportion of all characteristics is homogenous according to the experts' opinion for the utility validation of the quality assessment model for the e-learning systems for the HEIs of developing countries like Pakistan.

Table 8.16: Chi-square test

Chi-square	D*f*	P-value
1.25	5	0.9403

An analysis of means (ANOM) report is also generated that is described in Table 8.17. ANOM plot as presented in Figure 8.2 is also produced to determine which samples are significantly different from the grand mean.

Table 8.17: ANOM report

Sample	Size	Proportion
1	7	0.885714
2	7	0.8
3	7	0.657143
4	7	0.742857
5	7	0.771429

6	7	0.828571

Figure 8.2 shows the observed proportion for each of the samples. The Upper Decision Limit (UDL) is 1.15; Lower Decision Limit (LDL) is 0.41 and the Centerline is at 0.78. According to these limits set by ANOM, no sample is beyond UDL or LDL, which is indicating that all responses are almost identical and validating the usefulness of the proposed model for the HEIs. Furthermore, it is also observed from Figure 8.2 that there is no significant difference among the samples at the 95% confidence level.

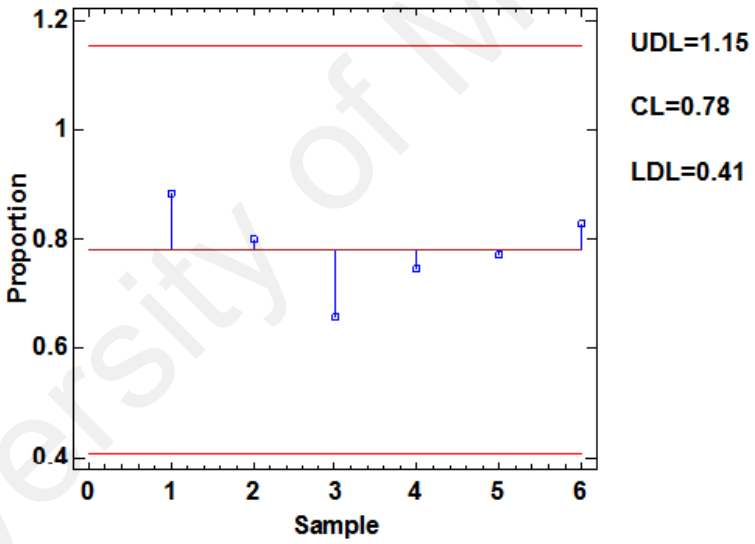


Figure 8.2: ANOM Plot for Utility

c) Comparison of Medians Test

The Kruskal-Wallis test (sometimes referred to as the Kruskal-Wallis H Test) has been deployed to gauge whether the mean response of all the experts is homogenous or not. Kruskal-Wallis test allows comparing more than two groups. Scores are converted to ranks and the mean rank for each group is compared. This is

a '*between-groups*' analysis, so different people must be in each of the different groups (Pallant, 2010). Following conditions have been formulated to employ Kruskal-Wallis test, in order to test that the mean response of all the respondents is same or homogeneous for all the items.

a) H_0: all medians are equal

   H_1: all medians are NOT equal

b) Significant: $\alpha \geq 0.05$

c) Test Statistics: Kruskal-Wallis

Table 8.18 illustrating the results obtained from the Kruskal-Wallis test. The p-value > 0.05 (i.e. 0.190), hence accepting H_0. This shows that the mean response of all the respondents is homogeneous for all the items.

Table 8.18: Kruskal-Wallis test

	N	Median	Average Rank
1	7	4.000	29.4
2	7	4.000	22.7
3	7	3.000	13.0
4	7	4.000	18.3
5	7	4.000	20.6
6	7	4.000	25.0
Overall	42		21.5

H = 7.44, Df = 5, P = 0.190

Wilcoxon Signed Rank test has been applied on the collected data to measure whether the respondents' response towards the utility validation of proposed model or not? Therefore, following hypothesis has been devised for the Wilcoxon Signed Rank test (median ≥ 3 versus median < 3);

a) H_0: The model is useful according to the opinion of experts

H_1: The model is not useful according to the opinion of experts

b) Test Statistic: Wilcoxon Signed Rank

c) Condition: median ≥ 3 versus median < 3

We set the average value = 3 (the median of 1, 2, 3, 4, 5) because the maximum possible response value is 5 if all experts are strongly agree, we can see from Table 8.19, that the median response is 3.00 (p = 0.209, i.e. accept the null hypothesis, i.e. ≥ 3 or valid). Thus we conclude that utility of the proposed model is validated towards its usefulness for the HEIs of Pakistan according to the experts' responses.

Table 8.19: Wilcoxon Signed Rank Test

N	N for Test	Wilcoxon Statistic	P	Estimated Median
7	5	4.0	0.209	3.00

8.2.4 Validation via Case Study

The objective of conducting this case study was to validate SQAMELS by evaluating the usefulness, ease of use, applicability and adaptability of the proposed model for the HEIs. The HEIs indulged in e-learning and/or blended learning paradigm were contacted. It was very difficult to convince the HEIs to participate in the case study. The main reasons for being unable to participate were lake of quality assessment experts and the time constraint. However, only one HEI i.e. AIOU, showed their willingness to participate in the case study.

8.2.4.1 Introduction to the Organization

AIOU is the first Open University in Asia and second Open University in the world, which was established in early 1974. Its philosophy, system, approach, functions and overall structure make this institution unique in Pakistan. Main campus of the university is situated in Islamabad whereas a huge network of regional campuses facilitating students all over Pakistan and in the Middle East. AIOU is providing multi-disciplinary education from basic to doctoral level programs adopting blended learning mode of education.

A Center of Instructional Design (CID) is established to cope with the increasing demands of digital learning. CID is facilitating the learners to learn through e-learning paradigm in addition to written material. Moreover, development and enhancement of the university's LMS (i.e. Online Learning Institute of Virtual Education (OLIVE)) of the university, development of instructional material, development of LOs according to the localized environment and etc. are some of the objectives of establishing CID. Besides CID, a FM radio channel, AIOU has a complete audio-visual studio to develop various learning materials in order to facilitate learners with the digital learning.

8.2.4.2 Selection of Experts

The expert's team comprised of ten experts working in various areas of e-learning system. These areas included software development, instructional design, academia and administration. All the respondents were competent in their area and having more than five years of experience.

8.2.4.3 Training

A training session with participants was conducted to brief the experts about various dimensions, utilization approach and process guidelines that how to apply SQAMELS for the quality assessment of LMS of AIOU. The introduction, objective, utilization of the SQAMELS and related documentations were provided to the participants and requested them to go through the documentations before briefing session.

8.2.4.4 Post-tasks

A post task survey questionnaire (Appendix-I) was conducted with the participants after the utilization of SQAMELS on the existing LMS of the targeted HEI. The respondents were requested to provide their opinions about the ease of use, usefulness, adaptability and applicability of the proposed model. Distribution of post-task survey questions in various perspectives is shown in Table 8.20.

Table 8.20: Distribution of Post-Task Questions in Various Perspectives

No.	Questionnaire	Perspective
1.	I found that the utilization approach of SQAMELS is easy to understand.	Ease of use
2.	I found the given process guidelines are clear and easy to understand.	
3.	I found that SQAMELS would reduce the effort required to assess the quality of e-learning.	Usefulness
4.	I found the procedure of applying the SQAMELS is simple and easy to use.	
5.	Overall, I found the SQAMELS to be useful in evaluating the quality of e-learning systems in software perspective.	
6.	It would be easy to adapt the SQAMELS to meet the requirements of HEIs regarding quality assessment of their e-learning systems.	Adaptability
7.	I found that adequate quality indicators of software perspective are covered in SQAMELS.	Applicability

8.	The SQAMELS utilization approach requires minimal training, so HEIs do not need to pay any training fee if they want to assess the quality of targeted e-learning systems using SQAMELS.	

8.2.4.5 Analysis and Interpretation of Results

Experts' responses to the post task questionnaire are presented in this section. The term "item" is used to refer to the question of the survey. Most of the items used to evaluate the SQAMELS are adapted from Memon (2014) and Nasir (2014). The items were transformed in order to make them appropriate to achieve the objectives of the case study. Four perspectives include ease of use, perceived usefulness; adaptability and applicability were considered to evaluate the SQAMELS. It can be found from Table 8.21 that the most prominent perception of SQAMELS possessed by the experts is ease of use having mean = 4.52 and Standard Deviation (SD) = 0.54, while usefulness of SQAMLES having mean = 4.16 and SD = 0.39, adaptability of SQAMELS is having mean = 4.10 and SD = 0.56 whereas the mean of applicability is 4.00 and SD is 0.47. The responses were obtained on the basis of five point Likert Scales (1, 2, 3, 4, and 5) whose mean = 3 because the possible maximum value is 5 if all the experts are strongly agree. The means of all the perceptions are greater than 4 and within the minimum and maximum values, which indicate that sampled experts perceived that SQAMELS is useful, easy to use, adaptable and applicable in the localized environment of developing countries like Pakistan.

Table 8.21: Descriptive Statistics

Perspective	Size (N)	Minimum	Maximum	Mean	Std. Deviation
Ease Of Use	10	3.50	5.00	4.25	0.54
Usefulness	10	3.67	4.67	4.16	0.39
Adaptability	10	3.00	5.00	4.10	0.56
Applicability	10	3.00	4.50	4.00	0.47

Now we discuss in depth analysis of devised perceptions individually on the basis of responses obtained from targeted experts.

a) Perceived ease of use

This perception was measured using two items on the post task survey (item no. 3 and 5). Now we present the results item by item.

Q3: I found that the utilization approach of SQAMELS is easy to understand.

Table 8.22 shows that 30% experts are strongly agreed and 70% are agreed that the approach defined for the utilization of SQAMELS is easy to understand. Here it has also been observed that neither a respondent strongly disagree nor disagree with the utilization approach of SQAMELS. This reflects that steps formulated for the deployment of SQAMELS are easy to understand.

Table 8.22: Percentages of responses for item No. 3

Sample	Size	Percentage
Strongly Agree	10	30
Agree	10	70
Neutral	10	0
Disagree	10	0
Strongly Agree	10	0

Q5: I found the given process guidelines are clear and easy to understand.

It is clear from Table 8.23 that 80% (40% strongly agree and 40% agree) of the respondents are agreed that the process guidelines devised for the implementation of SQAMELS are clear and easy to understand. While only 20% experts expressed their point of view as neutral regarding the process guidelines also it has also been observed that neither a respondent disagree nor strongly disagree with understandability of SQAMELS. Hence majority of the responses indicate that defined process guidelines are easy to understand without making any additional effort.

Table 8.23: Percentages of responses for item No. 5

Sample	Size	Percentage
Strongly Agree	10	40
Agree	10	40
Neutral	10	20
Disagree	10	0
Strongly Agree	10	0

Responses obtained from experts against items number 3 and 5 indicate that SQAMLES is perceived ease of use and the devised process guidelines for the implementation of SQAMELS are easy to understand for the quality assessment of e-learning systems.

b) Perceived usefulness

This perception was gauged using three items (questions 1, 4 and 8) on the post task survey.

Q1: I found that SQAMELS would reduce the effort required to assess the quality of e-learning.

Majority of the respondents 90% (40% strongly agree and 50% agree) as illustrated in Table 8.24 perceived that SQAMELS would reduce the effort required to assess the quality of e-learning systems, while mere (10%) of the respondents responded as neutral. Here it has also been observed that no response was reported either strongly disagree or disagree with the reduction of efforts required to assess the quality of e-learning system using SQAMELS.

Table 8.24: Percentages of responses for item No. 1

Sample	Size	Percentage
Strongly Agree	10	40
Agree	10	50
Neutral	10	10
Disagree	10	0
Strongly Agree	10	0

Q4: Overall, I found the SQAMELS to be useful in evaluating the quality of e-learning systems in software perspective.

It is given in the Table 8.25 that 10% are strongly agree and 90% are agreed that the SQAMELS is useful in order to evaluate the quality of e-learning system in software perspective. Here it has also been observed that neither a respondent strongly disagree nor disagree with the usefulness of SQAMELS.

Table 8.25: Percentages of responses for item No. 4

Sample	Size	Percentage
Strongly Agree	10	10
Agree	10	90
Neutral	10	0
Disagree	10	0

Strongly Agree	10	0

Q8: I found the procedure of applying the QAMELS is simple and easy to use.

Most of the respondents i.e. 80% (30% strongly agree, 50% agree) as shown in Table 8.26 are agreed that the procedure of quality assessment of e-learning system is simple and easy by applying SQAMELS while rest (20%) of the respondents response as neutral. Here it has also been observed that neither a respondent strongly disagree nor disagree with the simple and easy application procedure of SQAMELS.

Table 8.26: Percentages of responses for item No. 8

Sample	Size	Percentage
Strongly Agree	10	30
Agree	10	50
Neutral	10	20
Disagree	10	0
Strongly Agree	10	0

It has been perceived on the basis of results obtained from items (Q1, Q4 and Q8) that proposed mechanism is useful for the HEIs in order to assess the quality of e-learning system they are using or going to adopt. So it is evident that the SQAMELS has perceived usefulness.

c) Adaptability

This variable was measured using one item (question no. 6) on post task survey from experts.

Q6: It would be easy to adapt the SQAMELS to meet the requirements of HEIs regarding quality assessment of their e-learning systems.

It is found in Table 8.27 that most of the respondents 90% (20% strongly agree and 70% agree) perceived that SQAMELS is adaptable for the quality assessment of e-learning system for the HEIs. However, only 10% of the respondents showed their response as neutral. Moreover, it has also been observed that neither a respondent strongly disagree nor disagree with the adaptability of SQAMELS.

Table 8.27: Percentages of responses for item No. 6

Sample	Size	Percentage
Strongly Agree	10	20
Agree	10	70
Neutral	10	10
Disagree	10	0
Strongly Agree	10	0

On the basis of the responses of the experts, it has been perceived that SQAMELS is adaptable by the HEIs for the quality assessment of their e-learning systems.

d) Applicability

Whether the SQAMELS is applicable or not was measured using two items on post task survey (questions no. 2 and 7).

Q2: I found that adequate quality indicators of software perspective are covered in SQAMELS.

It is illustrated from Table 8.28 that 10% are strongly agreed and 80% are agreed about the applicability of the SQAMELS in order to assess the quality of e-learning system for the HEIs. Moreover, it has also perceived that only 10% of the respondents have responded as neutral regarding applicability of the SQAMELS.

However, neither a respondent strongly disagree nor disagree about the adequacy of the quality characteristics of the SQAMELS of software perspective.

Table 8.28: Percentages of responses for item No. 2

Sample	Size	Percentage
Strongly Agree	10	10
Agree	10	80
Neutral	10	10
Disagree	10	0
Strongly Agree	10	0

Q7: The SQAMELS utilization approach requires minimal training, so HEIs do not need to pay any training fee if they want to assess the quality of targeted e-learning systems using SQAMELS.

It is given in Table 8.29 that majority of the respondents i.e. 80% (20% strongly agree and 60% are agree) are agreed that the SQAMELS is affordable in terms that minimum training is required to implement SQAMLES for he quality assessment of e-learning systems. Here it has also perceived that only 20% of the respondents have responded as neutral about the training for the utilization of SQAMELS. However, no response was recorded either strongly disagree or disagree.

Table 8.29: Percentages of responses for item No. 7

Sample	Size	Percentage
Strongly Agree	10	20
Agree	10	60
Neutral	10	20
Disagree	10	0
Strongly Agree	10	0

On the basis of the results obtained from item number 2 and 7, majority of the experts perceived that SQAMELS is applicable for the HEIs to assess the quality of their e-learning systems.

Responses obtained from post-task survey indicate that SQAMELS is applicable to the existing localized environment of developing countries like Pakistan. Moreover, results emphasized that minimum training is required in order to apply SQAMELS on e-learning systems.

8.3 Summary

This chapter discussed the validation of the proposed model adopting four validation techniques. These techniques include comparison of the quality characteristics addressed by SQAMELS with the frameworks and models from the existing literature, two different survey questionnaires; one from practitioners and other from experts' and applying the proposed model to an existing LMS of one of the HEIs of Pakistan. The quantitative data collected from practitioners and experts have been analyzed adopting a series of statistical test to ensure the validation of the proposed model. Moreover, a post-task survey has also been conducted with e-learning experts participated in the conducted case study in order to gauge the perceived ease of use, perceived usefulness, affordability and applicability of the SQAMELS for HEIs. The results obtained from the entire validation methods advocate that SQAMELS is easy to use, useful, adaptable and applicable for the quality assessment of e-learning systems based on the software perspective.

CHAPTER 9: CONCLUSION AND FUTURE WORK

This research has been conducted to investigate the critical challenges faced by the HEIs of Pakistan in implementing e-learning and quality assessment practices for the e-learning systems in various perspectives. This chapter reinstates the research findings with respect to their research objectives and research questions which have been answered during the progression of this research. In addition, this chapter also provides the implication for the researchers and practitioners, highlights the contributions, determines the limitations and shed light on the future directions of this research.

Quality of a software system is difficult to measure but at the same time it is crucial for a software system to be sustainable. The quality of an e-learning system is twofold in nature: 1) pedagogical or education and 2) software. There is no single design and ultimate solution to assess the quality of e-learning systems. Various HEIs are assessing and measuring quality of their adopted e-learning system in their own way, as there is no clear guidance for assessing the quality of an e-learning system. Hence, this research commences to establish a quality assessment model for the e-learning systems for the HEIs for developing countries. This research inspects the critical challenges facing by the HEIs in shifting from traditional to lifelong learning paradigm by implementing e-learning system. The research attracts the decision makers of HEIs in order to assess the quality of their e-learning systems. Moreover, this study also provides a roadmap to various stakeholders of e-learning system for the quality assessment of their e-learning systems in developing countries in general and Pakistan in particular.

9.1 Addressing the Research Objectives

Now we discuss the responses to the underlying research objectives formulated for this study one by one;

- **Research Objective 1 [Identification of Issues/Challenges]:**

  To identify the current issues, challenges and their impact on the adoption and implementation of e-learning in developing countries like Pakistan.

  A comprehensive set of e-learning challenges has been identified by conducting an intensive review of the literature. The identified challenges are then probe in detail to highlight the impact of each challenge on the implementation of e-learning. These challenges are classified into five categories. These categories are software, technical, personal, institutional and cultural. The challenges are then ranked according to their importance and criticality for the localized environment of Pakistan. One of the top crucial challenges has been selected as research focus for this study which is the lack of quality assurance mechanism for e-learning systems.

- **Research Objective 2 [Analysis of Existing Frameworks and Models]:**

  To critically analyze the existing quality frameworks and models of e-learning systems.

  Systematic literature review has been performed in order to reach the research objective 2. Sixteen potential studies have been identified after a rigor review of the literature regarding quality assurance, assessment or evaluation mechanism for the e-learning systems. Most of these identified studies (75%)

have addressed the pedagogical perspective of the e-learning systems. These studies have addressed various aspects of pedagogy ranging from contents to learner and learner satisfaction. However, only four studies (25%) have addressed different quality characteristics in software perspective. These characteristics include usability, efficiency, functionality etc.

- **Research Objective 3 [Collection of Potential Quality Characteristics]:**

  To identify main characteristics and sub-characteristics of e-learning quality from the existing literature.

  This objective has been accomplished by conducting Systematic Literature Review. An exhaustive list of potential quality characteristics have been formulated irrespective of the perspective in which these quality characteristics have been proposed. Totally 42 quality characteristics have been collected from existing e-learning quality models and frameworks. The quality characteristic which is addressed by 60% of the identified studies is instructional design/content. The learner and technology characteristics are addressed by different studies with the frequency of 46% and 40% respectively. The characteristics of evaluation, performance and interface are addressed by 6% of the studies only.

- **Research Objective 4 [Proposing Model]:**

  To propose a sustainable model for the quality assessment of e-learning systems for HEIs of developing countries in software perspective.

The research objective 4 has been achieved by proposing a sustainable quality assessment model for the e-learning systems. Before proposing the model, an empirical study has been conducted with the e-learning experts. Various statistical tests have been applied on the data obtained from empirical study. These statistical tests include Principal Component Analysis, Logistic regression, Chi-square and Kappa statistics. The output of statistical analysis leads this study towards the proposition of the sustainable quality assessment model for e-learning system.

The proposed model is divided into three major dimensions. These dimensions include system, service and charisma (attractiveness). Each dimension consists of various quality characteristics to represent specified dimension collectively. These quality characteristics are further divided into sub-characteristics to gauge the quality of the e-learning system in more depth. These quality characteristics are adequate to assess the e-learning system at least up to the satisfactory level. Quality characteristics can be included or excluded from the model accordingly to meet the requirements of the organization. A process guideline has also been articulated on how to utilize the proposed model. Moreover, each of the quality characteristic is associated to certain operation such as network, existing and future operations.

- **Research Objective 5 [Validation]:**

Four methods have been utilized to validate the proposed model. These methods include a) comparison of the features with existing e-learning quality models and frameworks, b) survey analysis by practitioners to measure its applicability c) experts review using survey instrument to gauge its usefulness and d) a case

study to assess the usefulness, ease of use, applicability and adaptability of the proposed model for the HEIs.

The e-learning experts have been divided into two groups. One group comprises of practitioners including software engineer, instructional designers, developers, managers and directors (IT/ICT). The other group consists of experts including academicians and researchers in the e-learning arena. For the applicability validity, practitioners have validated the model by gauging the appropriateness of the model that is how well it is fit to address the various aspects of software perspective for an e-learning system. On the other hand, the experts have validated the model by evaluating the usefulness of the model, that is the how much is the likelihood of adoption of the model in practice.

9.2 Research Contributions

This research proposes a quality assessment model focusing on the software perspective of the e-learning systems. Major contributions of this research are as follows;

a) Development of the sustainable quality assessment model in software perspective for the e-learning system. This model addresses the minimum requirement of HEIs of developing countries in order to assess the e-learning system they are using or intend to adopt. A simple method for the utilization of the proposed model has also been formulated. The model can be used not only address the existing situation of the organization but also capable to address the future needs of the organization by considering the quality characteristic like sustainability. The sustainability of an e-learning system can be gauged in terms

of scalability, portability and extendibility. These features make this model distinct from the existing quality frameworks and models for e-learning systems.

b) Collection and formulation of an exhaustive list of quality characteristics for the e-learning systems based on the conducted SLR and experts' interviews. These quality characteristics have been divided into three different categories including education or pedagogy, software and miscellaneous. Pedagogical activities includes contents, instructional design, delivery of contents, instructors, learners and etc. whereas software perspective include the characteristics like usability, availability, security, reliability etc. In addition to these two categories, some quality characteristics have also identified which do not fall in either category. These are placed in miscellaneous category which includes the characteristics like emotional intelligence, IT-ability, technical infrastructure etc.

c) Identification of the critical challenges for the implementation and promotion of e-learning for developing countries in general and for Pakistan in particular. Each challenge and its impact have been analyzed in depth in order to tackle it accordingly.

d) A hierarchal model to rank the critical challenges of e-learning has been developed. A new dimension of "software" for the e-learning system has also been identified which addresses the challenges related to the software perspective of e-learning systems. The dimensions other than software are personal, institutional and cultural. The identified challenges have been categories into respective dimensions to highlight that which challenge falls in which category. So that every challenge should be addressed by the appropriate authority responsible for the achievement of the aim i.e. "education for all" set by of GOP.

e) Provision of process guidelines regarding the utilization of SQAMELS. These guidelines help academicians and practitioners in assessing the quality of an e-learning system they are using or intend to use.

9.3 Research Limitations

There are still several limitations in this work. These limitations are as follows;

a) There are various dimensions of e-learning system including pedagogical, personal, institutional, software, cultural, technical and so on. All dimensions are important for the successful implementation and promotion of e-learning system. Numerous challenges are associated with each dimension. This research is limited to address the quality issues and challenges focusing on software perspective only.

b) There are many stakeholders of an e-learning system. These stakeholders include learners or users, instructors or faculty, institutions, administration, software developers, instructional designers, managers, online facilitators, multi-media designers, learning objects developers and so on. Each stakeholder has their own views, opinions and requirements about the quality assessment of an e-learning system. This research is limited to focus only on three stakeholders of e-learning system including administrators, academicians/researchers and developers.

c) This study has limited scope of participants from one country only which is Pakistan. This work can be generalized or enhanced by collecting data from various countries.

9.4 Future Work

1. More research can be performed to consider other stakeholders like learners, instructional designers and multimedia designers.
2. The proposed model can be enhanced by taking participants from the other developing countries like Malaysia, Bangladesh, India, Iran etc.
3. The research can be boosted by considering other perspectives like technical, cultural, contents, institutions and etc.
4. A few directions also emerge from this study such as lack of development process for learning objects, identification of challenges for the cloud based e-learning systems and impact of the culture on the quality of e-learning system.

REFERENCES

Abdellatief, M. S., A.B.M. Jabar, M.A. Abdullah, R. (2011). A Technique for Quality Evaluation of E-Learning from Developers Perspective. *American Journal of Economics and Business Administration, 3*(1), 157-164.

Abdous, M. h. (2009). E-Learning quality assurance: a process-oriented lifecycle model. *Quality Assurance in Education, 17*(3), 281-295.

Abidin, M. J. Z., Rezaee, A. A., Abdullah, H. N., & Singh, K. K. B. (2011). Learning styles and overall academic achievement in a specific educational system. *International Journal of Humanities and Social Science, 1*(10), 143-152.

Agresti, A. (2013). *Categorical data analysis*: John Wiley & Sons.

Akar, E., Öztürk, E., Tunc, B., & Wiethoff, M. (2004). Evaluation of a collaborative virtual learning environment. *Education+ Training, 46*(6/7), 343-352.

Al-Busaidi, K. A., & Al-Shihi, H. (2012). Key factors to instructors' satisfaction of learning management systems in blended learning. *Journal of Computing in Higher Education, 24*(1), 18-39.

Al-Kilidar, H., Cox, K., & Kitchenham, B. (2005). *The use and usefulness of the ISO/IEC 9126 quality standard.* Paper presented at the International Symposium on Empirical Software Engineering, 2005.

Al-Qutaish, R. E. (2010). Quality models in software engineering literature: an analytical and comparative study. *Journal of American Science, 6*(3), 166-175.

Alla, M. M. S. O. (2013). The Impact of System Quality in E-learning System. *Journal of Computer Science and Information Technology, 1*(2).

Andersson, A. (2008). Seven major challenges for e-learning in developing countries: Case study eBIT, Sri Lanka. *International Journal of Education and Development using ICT, 4*(3).

Andersson, A. S., & Grönlund, Å. (2009). A conceptual framework for e-learning in developing countries: A critical review of research challenges. *The Electronic Journal of Information Systems in Developing Countries, 38*.

Anuwar, A., & Datuk, T. S. (2004). Issues and challenges in implementing e-learning in Malaysia.

Ardito, C., Costabile, M. F., De Marsico, M., Lanzilotti, R., Levialdi, S., Roselli, T., & Rossano, V. (2006). An approach to usability evaluation of e-learning applications. *Universal access in the information society, 4*(3), 270-283.

Arnold, B. L., Gansneder, B. M., & Perrin, D. H. (2005). *Research methods in athletic training*: FA Davis Company.

Austin, E. K. (1981). *Guidelines for the development of continuing education offerings for nurses*. New York: Appleton-Century-Crofts.

Azen, R., & Walker, C. M. (2011). *Categorical data analysis for the behavioral and social sciences*: Routledge.

Babu, N. S. C. (2005). Quality Assurance Framework for e-Learning. *ELEL Tech, India*.

Bailey, K. (2008). *Methods of social research*: Free Press.

Barbosa, E. F., & Maldonado, J. C. (2006). *Towards the establishment of a standard process for developing educational modules.* Paper presented at the Frontiers in Education Conference, 36th Annual.

Barriball, K. L., & While, A. (1994). Collecting data using a semi-structured interview: a discussion paper. *Journal of Advanced Nursing-Institutional Subscription, 19*(2), 328-335.

Baruque, L. B., Baruque, C. B., & Melo, R. N. (2007). *Towards a framework for corporate e-learning evaluation.* Paper presented at the Proceedings of the 2007 Euro American conference on Telematics and information systems.

Baumeister, R. F. (2013). Writing a literature review *The Portable Mentor* (pp. 119-132): Springer

Behkamal, B., Kahani, M., & Akbari, M. K. (2009). Customizing ISO 9126 quality model for evaluation of B2B applications. *Information and software technology, 51*(3), 599-609.

Berger, T., & Rockmann, U. (2006). Quality of e-learning products *Handbook on Quality and Standardisation in E-Learning* (pp. 143-155): Springer

Bhatti, S. N. (2005). Why quality?: ISO 9126 software quality metrics (Functionality) support by UML suite. *ACM SIGSOFT Software Engineering Notes, 30*(2), 1-5.

Bhuasiri, W., Xaymoungkhoun, O., Zo, H., Rho, J. J., & Ciganek, A. P. (2012). Critical success factors for e-learning in developing countries: A comparative analysis between ICT experts and faculty. *Computers & Education, 58*(2), 843-855.

Bleimann, U. (2004). Atlantis University: a new pedagogical approach beyond e-learning. *Campus-Wide Information Systems, 21*(5), 191-195.

Boehm, B. W., Brown, J. R., Kaspar, H., Lipow, M., MacLeod, G. J., & Merrit, M. J. (1978). *Characteristics of software quality* (Vol. 1): North-Holland Publishing Company.

Bryman, A. (2012). *Social research methods*: Oxford university press.

Burton, L. J., & Mazerolle, S. M. (2011). Survey instrument validity part I: Priincipals of Survey Instrument Development and Validation in Athletic Education Training Research. *Atheltic Training Education Journal, 6*(1), 27-35.

Burton, L. J., & Mazerolle, S. M. (2011). Survey Instrument Validity Part I: Principles of Survey Instrument Development and Validation in Athletic Training Education Research. *Athletic Training Education Journal, 6*(1), 27-35.

Calder, J. (1998). *Open & flexible learning in vocational education and training*: Routledge.

Caramihai, M., & Severin, I. (2009). eLearning Tools Evaluation based on Quality Concept Distance Computing. A Case Study. *World Academy of Science, Engineering and Technology*.

Carr, J. (1999). The role of higher education in the effective delivery of multimedia management training to small and medium-sized enterprises. *Educational Technology & Society, 2*(2), 1-15.

Castro, F. G., Kellison, J. G., Boyd, S. J., & Kopak, A. (2010). A methodology for conducting integrative mixed methods research and data analyses. *Journal of mixed methods research, 4*(4), 342-360.

Chua, B. B., & Dyson, L. E. (2004). *Applying the ISO 9126 model to the evaluation of an elearning system.* Paper presented at the Proc. of ASCILITE.

Clark, V. L. P., Huddleston-Casas, C. A., Churchill, S. L., Green, D. O. N., & Garrett, A. L. (2008). Mixed methods approaches in family science research. *Journal of Family Issues, 29*(11), 1543-1566.

Clements, P. C. (2002). *Software architecture in practice.* Carnegie Mellon University.

Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches*: Sage publications.

Creswell, J. W., & Clark, V. L. P. (2007). Designing and conducting mixed methods research.

Creswell, J. W., Klassen, A. C., Plano Clark, V. L., & Smith, K. C. (2011). Best practices for mixed methods research in the health sciences. *Bethesda (Maryland): National Institutes of Health*.

Croxall, K., & Cummings, M. N. (2000). Computer usage in family and consumer sciences classrooms. *Journal of Family and Consumer Sciences Education, 18*(1), 9-18.

Curran, C. (2001). The phenomenon of on-line learning. *European Journal of Education*, 113-132.

Darling, L. (2002). Your ELearning Strategy: Make sure it's learning for results. *Training, 39*(3), 2.

Dearing, R. (1997). Higher education in the learning society [Dearing report].

Differding, C., Hoisl, B., & Lott, C. (1996). Technology Package for the Goal Question Metric Paradigm (Internal Report No. 281/96). *Kaiserslautern: University of Kaiserslautern.*

Dillon, C. L., & Gunawardena, C. N. (1995). *A framework for the evaluation of telecommunications-based distance education.* Paper presented at the Selected papers from the 17th world congress of the International Council for Distance Education.

Djouab, R., & Bari, M. (2016). An ISO 9126 Based Quality Model for the e-Learning Systems. *International Journal of Information and Education Technology, 6*(5). doi: 10.7763/IJIET.2016.V6.716

Dromey, R. G. (1995). A model for software product quality. *Software Engineering, IEEE Transactions on, 21*(2), 146-162.

Drost, E. A. (2011). Validity and reliability in social science research. *Education Research and Perspectives, 38*(1), 105.

Easterbrook, S., Singer, J., Storey, M.-A., & Damian, D. (2008). Selecting empirical methods for software engineering research *Guide to advanced empirical software engineering* (pp. 285-311): Springer

Ehlers, U. D. (2004). Quality in e-learning. The learner as a key quality assurance category. *European Journal of Vocational Training, 29*, 3-15.

El-Khatib, K., Korba, L., Xu, Y., & Yee, G. (2003). Privacy and security in e-learning. *International Journal of Distance Education Technologies (IJDET), 1*(4), 1-19.

Farid, S., Ahmad, R., & Alam, M. (2015). A Hierarchical Model for E-Learning Implementation Challenges using AHP. *Malaysian Journal of Computer Science, 28*(3).

Farid, S., Ahmad, R., Niaz, I., Itmazi, J., & Asghar, K. (2014). *Identifying Perceived Challenges of E-Learning Implementation.* Paper presented at the First International Conference on Modern Communication & Computing Technologies (MCCT'14), Nawabshah, Pakistan.

Farid, S., Ahmad, R., Niaz, I. A., Arif, M., Shamsherband, S., & Daud Khattak, M. (2015). Identification and prioritization of critical issues for the promotion of e-learning in Pakistan. *Computers in Human Behavior 51*, 161-171.

Finance, M. o. (2014). *Pakistan Economic Survey 2013-14*.

Finlay, L. (2002). "Outing" the researcher: The provenance, process, and practice of reflexivity. *Qualitative health research, 12*(4), 531-545.

Forgionne, G. A., Kohli, R., & Jennings, D. (2002). An AHP analysis of quality in AI and DSS journals. *Omega, 30*(3), 171-183.

Forman, D., Nyatanga, L., & Rich, T. (2002). E-learning and educational diversity. *Nurse Education Today, 22*(1), 76-82.

Freire, P. (1994). Pedagogy of the oppressed, London, UK: Continuum.

Fresen, J. W., & Boyd, L. G. (2005). Caught in the web of quality. *International Journal of Educational Development, 25*(3), 317-331.

Gaber, J. (2010). *Encyclopedia of Research Design - Face Validity* (N. J. Salkind Ed.). Thousand Oaks: SAGE Publications, Inc.

Gammill, T., & Newman, M. (2005). Factors associated with faculty use of web-based instruction in higher education. *Journal of Agricultural Education*.

Ghezzi, C., Jazayeri, M., & Mandrioli, D. (1991). Fundamentals of software engineering.

Gorden, R. L. (1975). *Interviewing: Strategy, Techniques, and Tactics*: "The" Dorsey Press.

Govindasamy, T. (2001). Successful implementation of e-learning: Pedagogical considerations. *The Internet and Higher Education, 4*(3), 287-299.

Grady, R. B., & Caswell, D. L. (1987). Software metrics: establishing a company-wide program.

Gray, D. E. (2004). *Doing Research in the Real World*: SAGE Publications Limited.

Grönlund, Å., & Islam, Y. M. (2010). A mobile e-learning environment for developing countries: The Bangladesh virtual interactive classroom. *Information Technology for Development, 16*(4), 244-259.

Gulati, S. (2008). Technology-enhanced learning in developing nations: A review. *The International Review of Research in Open and Distance Learning, 9*(1).

GÜLER, Ç., & Altun, A. (2010). Teacher trainees as learning object designers: Problems and issues in learning object development process. *TOJET, 9*(4).

Hammersley, M. (1990). *Reading ethnographic research: A critical guide*: Longman.

Hancock, B., Ockleford, E., & Windridge, K. (1998). *An introduction to qualitative research*: Trent focus group Nottingham.

Harper, S., & Chen, A. Q. (2012). Web accessibility guidelines. *World Wide Web, 15*(1), 61-88.

Hassanzadeh, A., Kanaani, F., & Elahi, S. (2012). A model for measuring e-learning systems success in universities. *Expert Systems with Applications, 39*(12), 10959-10966.

Hasson, F., Keeney, S., & McKenna, H. (2000). Research guidelines for the Delphi survey technique. *Journal of advanced nursing, 32*(4), 1008-1015.

HEC. (2013). Higher Education Commission, Pakistan. Retrieved 14.07.2014, 2014, from http://www.hec.gov.pk/InsideHEC/Divisions/eReforms/Pages/Main.aspx

Hiltz, S. R. (1997). Impacts of college-level courses via asynchronous learning networks: Some preliminary results. *Journal of Asynchronous Learning Networks, 1*(2), 1-19.

Holley, D. (2002). Which room is the virtual seminar in please? *Education+ Training, 44*(3), 112-121.

Homan, G., & Macpherson, A. (2005). E-learning in the corporate university. *Journal of European Industrial Training, 29*(1), 75-90.

Hrastinski, S. (2008). Asynchronous and synchronous e-learning. *Educause quarterly, 31*(4), 51-55.

Hvorecký, J., Manažmentu, V., & Cesta, P. (2005). Can E-learning break the Digital Divide. *European Journal of Open, Distance and E-Learning. Retrieved April, 10*, 2007.

Hyder, K., Kwinn, A., Miazga, R., & Murray, M. (2007). Synchronous e-learning. *The eLearning Guild*.

Inglis, A. (2005). Quality improvement, quality assurance, and benchmarking: comparing two frameworks for managing quality processes in open and distance learning. *The International Review of Research in Open and Distributed Learning, 6*(1).

Inglis, A. (2008). Approaches to the validation of quality frameworks for e-learning. *Quality Assurance in Education, 16*(4), 347-362.

Inglis, A., Joosten, V., & Ling, P. (2002). *Delivering digitally: Managing the transition to the new knowledge media* (2nd ed.): Routledge.

Ip, A., Morrison, I., & Currie, M. (2001). What is a learning object, technically? : ERIC Clearinghouse.

Iqbal, M. J., & Ahmed, M. (2010). Enhancing quality of education through e-learning: the case study of Allama Iqbal Open University. *The Turkish Online Journal of Distance Education, 11*(1).

Ireland, J., Correia, H. M., & Griffin, T. M. (2009). Developing quality in e-learning: a framework in three parts. *Quality assurance in education, 17*(3), 250-263.

Isik, O. (2008). *E-learning Satisfaction Factors*. Paper presented at the Proceedings of the 39th Annual Meeting of the Decision Sciences Institute, Baltimore.

Islam, M. T., & Selim, A. S. M. (2006). Current status and prospects for e-learning in the promotion of distance education in Bangladesh. *Turkish Online Journal of Distance Education, 7*(1), 114-119.

ISO, I. (2001). IEC 9126-1: Software Engineering-Product Quality-Part 1: Quality Model. *Geneva, Switzerland: International Organization for Standardization*.

ISO, W. (1998). 9241-11. Ergonomic requirements for office work with visual display terminals (VDTs). *The international organization for standardization*.

Ivergård, T., & Hunt, B. (2005). Towards a learning networked organisation: human capital, compatibility and usability in e-learning systems. *Applied ergonomics, 36*(2), 157-164.

Jamwal, D. (2010). Analysis of Software Quality Models for Organizations. *International Journal of Latest Trends in Computing (E-ISSN: 2045-5364), 19*.

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. *Journal of mixed methods research, 1*(2), 112-133.

Jung, I. (2011). The dimensions of e-learning quality: from the learner's perspective. *Educational Technology Research and Development, 59*(4), 445-464.

Kajornboon, A. B. (2005). Using interviews as research instruments. *E-Journal for Research Teachers, 2*(1).

Kamba, M. (2009). Problems, challenges and benefits of implementing e-learning in Nigerian universities: An empirical study. *International Journal of Emerging Technologies in Learning (iJET), 4*(1).

Khan, A. (2007). The Education System and Prospects for e-learning in Pakistan. *End-to-End eLearning, Stockholm College, Stockholm*.

Khan, B. H. (2003). The global e-learning framework. *STRIDE*, 42.

Khattak, D. (2010). *Development of Multimedia Instruction Objects for Delivery in a Localized E-Learning Environment.* (Ph.D.), Allama Iqbal Open University, Islamabad, Pakistan.

Khosravi, K., & Guéhéneuc, Y.-G. (2004). *On issues with software quality models.* Paper presented at the The Proceedings of the 11th Working Conference on Reverse Engineering. GEODES.

Kitchenham, B. A., & Charters, S. (2007). Guidelines for performing systematic literature reviews in software engineering.

Koohang, A., Riley, L., Smith, T., & Schreurs, J. (2009). E-learning and constructivism: from theory to application. *Interdisciplinary Journal of E-Learning and Learning Objects, 5*(1), 91-109.

Kumar, A., Kumar, R., & Grover, P. (2006). *A Change Impact Assessment in Aspect-Oriented Software Systems.* Paper presented at the International Software Engineering Conference Russia.

Kundi, G. M., Nawaz, A., & Khan, S. (2010). The predictors of success for e-learning in higher education institutions (HEIs) in NW. FP, Pakistan. *JISTEM-Journal of Information Systems and Technology Management, 7*(3), 545-578.

Kylli, J.-P. (2005). The future of eLearning. A short History of eLearning and a Look into the Future of Computer Mediated Learning.

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *biometrics*, 159-174.

Lanzilotti, R., Ardito, C., Costabile, M. F., & De Angeli, A. (2006). eLSE methodology: a systematic approach to the e-learning systems evaluation. *Educational Technology & Society, 9*(4), 42-53.

Latif, A. (2011). Alarming situation of education in Pakistan. *Press International Report*.

Lau, R. W., Yen, N. Y., Li, F., & Wah, B. (2013). Recent development in multimedia e-learning technologies. *World Wide Web*, 1-10.

Law, R., & Leung, R. (2000). A study of airlines' online reservation services on the Internet. *Journal of Travel Research, 39*(2), 202-211.

Lee, G.-G., & Lin, H.-F. (2005). Customer perceptions of e-service quality in online shopping. *International Journal of Retail & Distribution Management, 33*(2), 161-176.

Lee, J.-K., & Lee, W.-K. (2008). The relationship of e-Learner's self-regulatory efficacy and perception of e-Learning environmental quality. *Computers in Human Behavior, 24*(1), 32-47.

Leidner, D. E., & Jarvenpaa, S. L. (1993). The information age confronts education: Case studies on electronic classrooms. *Information Systems Research, 4*(1), 24-54.

Levy, S. (2003). Six factors to consider when planning online distance learning programs in higher education. *Online Journal of Distance Learning Administration, 6*(1).

Li, F. (2009). *Design of a quality control framework for corporate e-learning systems*. University of Regina.

Lin, H.-F. (2010). An application of fuzzy AHP for evaluating course website quality. *Computers & Education, 54*(4), 877-888.

Lirn, T., Thanopoulou, H., Beynon, M. J., & Beresford, A. K. C. (2004). An application of AHP on transhipment port selection: a global perspective. *Maritime Economics & Logistics, 6*(1), 70-91.

Littlejohn, A. (2003). Supporting sustainable e-learning. *Research in Learning Technology, 11*(3).

Macharis, C., Springael, J., De Brucker, K., & Verbeke, A. (2004). PROMETHEE and AHP: The design of operational synergies in multicriteria analysis.: Strengthening PROMETHEE with ideas of AHP. *European Journal of Operational Research, 153*(2), 307-317.

Maher Alghali, H. M. A. N., I. Roesnita. (2014). *Challenges and Benefits of Implementing Cloud Based E-Learning in Developing Countries*. Paper presented at the Proceeding of the Social Sciences Research ICSSR 2014, Kota Kinabalu,Sabah, MALAYSIA.

Mapuva, J. (2009). Confronting challenges to e-learning in Higher Education Institutions. *International Journal of Education and Development Using ICT, 5*(3), 101-114.

Mardle, S., Pascoe, S., & Herrero, I. (2004). Management objective importance in fisheries: an evaluation using the analytic hierarchy process (AHP). *Environmental Management, 33*(1), 1-11.

Mason, R., & Rennie, F. (2004). Broadband: A solution for rural e-Learning? *The International Review of Research in Open and Distance Learning, 5*(1).

Masoumi, D. (2010). Quality in E-learning within a cultural context.

Masoumi, D., & Lindström, B. (2012). Quality in e-learning: a framework for promoting and assuring quality in virtual institutions. *Journal of Computer Assisted Learning, 28*(1), 27-41.

Mathers, N., Fox, N., & Hunn, A. (1998). Trent focus for research and development in primary health care: Using interviews in a research project. *Retrieved May, 2*, 2003.

Mavromoustakos, S., & Andreou, A. S. (2007). WAQE: a web application quality evaluation model. *International Journal of web engineering and technology, 3*(1), 96-120.

Maxwell, J. A. (2012). *Qualitative research design: An interactive approach: An interactive approach* (Vol. 41): Sage.

McCall, J. A., Richards, P. K., & Walters, G. F. (1977). *Factors in software quality*: General Electric, National Technical Information Service.

McCullagh, P., Nelder, J. A., & McCullagh, P. (1989). *Generalized linear models* (Vol. 2): Chapman and Hall London.

McGorry, S. Y. (2003). Measuring quality in online programs. *The Internet and Higher Education, 6*(2), 159-177.

Mehnaz Aziz, D. E. B., Salal Humair, Emmanuel Jimenez, Larry Rosenberg, Zeba Sathar. (2014). Education System Reform in Pakistan: Why, When, and How? *IZA Policy Paper Series*. Germany: Institute for the Study of Labor.

Memon, R. N. (2014). *Problem Structuring and Analysis Method Based on Soft System Methodology for Teaching Requirements Engineering*. (Ph.D.), University of Malaya, Kuala Lumpur, Malaysia.

Meredith, S., & Newton, B. (2003). Models of eLearning: Technology promise vs learner needs literature review. *The International Journal of Management Education, 3*(3), 43-56.

Miles, M. B., & Huberman, A. M. (1985). *Qualitative data analysis*: Sage Newbury Park,, CA.

Monahan, T., McArdle, G., & Bertolotto, M. (2008). Virtual reality for collaborative e-learning. *Computers & Education, 50*(4), 1339-1353.

Moore, J. C. (2002). *Elements of Quality: The Sloan-C Tm Framework*: Olin College-Sloan-C.

Moore, J. L., Dickson-Deane, C., & Galyen, K. (2011). e-Learning, online learning, and distance learning environments: Are they the same? *The Internet and Higher Education, 14*(2), 129-135.

Moussa, N., & Moussa, S. (2009). Quality assurance of e-learning in developing countries. *Nonlinear Analysis: Theory, Methods & Applications, 71*(12), e32-e34.

Muñoz, S. R., & Bangdiwala, S. I. (1997). Interpretation of Kappa and B statistics measures of agreement. *Journal of Applied Statistics, 24*(1), 105-112.

Nabil, D., Mosad, A., & Hefny, H. A. (2011). Web-Based Applications quality factors: A survey and a proposed conceptual model. *Egyptian Informatics Journal, 12*(3), 211-217.

Nasir, M. H. N. B. M. (2014). *ENHANCED SOFTWARE PROJECT MANAGEMENT METHODOLOGY FOR MALAYSIAN SMALL MEDIUM ENTERPRISES.* University Technology Malaysia.

Nawaz, A. (2012). E-Learning experiences of HEIs in advanced states, developing countries and Pakistan. *Universal Journal of Education and General Studies, 1*(3), 72-83.

Nawaz, A., & Khan, M. Z. (2012). Issues of Technical Support for e-Learning Systems in Higher Education Institutions. *International Journal of Modern Education and Computer Science (IJMECS), 4*(2), 38.

Netemeyer, R. G., Bearden, W. O., & Sharma, S. (2003). *Scaling procedures: Issues and applications*: Sage Publications.

Niazi, M., Wilson, D., & Zowghi, D. (2005). A framework for assisting the design of effective software process improvement implementation strategies. *Journal of Systems and Software, 78*(2), 204-222.

Nicholson, P. (2007). A history of e-learning *Computers and education* (pp. 1-11): Springer

Nunnally Jum, C., & Bernstein Ira, H. (1978). Psychometric theory: New York: McGraw-Hill.

Oliver, R. (2001). Assuring the quality of online learning in Australian higher education.

Oliver, R. (2005). Quality assurance and e-learning: blue skies and pragmatism. *Research in Learning Technology, 13*(3).

Oliver, R., & Herrington, J. (2001). *Teaching and learning online: A beginner's guide to e-learning and e-teaching in higher education*: Edith Cowan University. Centre for Research in Information Technology and Communications.

Olsina, L., Lafuente, G., & Rossi, G. (2001). Specifying quality characteristics and attributes for websites *Web Engineering* (pp. 266-278): Springer

Ozkan, S., & Koseler, R. (2009). Multi-dimensional students' evaluation of e-learning systems in the higher education context: An empirical investigation. *Computers & Education, 53*(4), 1285-1296.

Padayachee, I., Kotze, P., & van Der Merwe, A. (2010). ISO 9126 external systems quality characteristics, sub-characteristics and domain specific criteria for

evaluating e-Learning systems. *The Southern African Computer Lecturers' Association, University of Pretoria, South Africa*.

Pagram, P., & Pagram, J. (2006). Issues in e-learning: A Thai case study. *The Electronic Journal of Information Systems in Developing Countries, 26*.

Pallant, J. (2010). SPSS survival manual: a step by step guide to data analysis using SPSS. England: Open University Press.

Palloff, R. M., & Pratt, K. (2000). *Making the transition: Helping teachers to teach online*: ERIC Clearinghouse.

Pantel, C. (1997). *A framework for comparing web-based learning environments*. Citeseer.

Patton, M. (2002). Qualitative research & evaluation methods.

Pawlowski, J. M. (2003). *The European Quality Observatory (EQO): structuring quality approaches for e-learning*. Paper presented at the Proceedings of The 3rd IEEE International Conference on Advanced Learning Technologies, 2003.

Penna, M. P., & Stara, V. (2008). Approaches to E-Learning Quality Assessment.

Perraton, H. D. (2007). *Open and distance learning in the developing world*: Routledge.

Põldoja, H., Väljataga, T., Laanpere, M., & Tammets, K. (2012). Web-based self-and peer-assessment of teachers' digital competencies. *World Wide Web*, 1-15.

Pressman, R. S. (2005). Software engineering: a practitioner's approach. *McGraw Hill International Edition*, 466-472.

PTA. (2012). *Annual Report*. Islamabad.

Punyabukkana, P., Sowanwanichakul, B., & Suchato, A. (2006). *RELAD: A Rapid eLearning Authoring and Development Model.* Paper presented at the Third International Conference on eLearning for Knowledge-Based Society.

Qureshi, I. A., Ilyas, K., Yasmin, R., & Whitty, M. (2012). Challenges of implementing e-learning in a Pakistani university. *Knowledge Management & E-Learning: An International Journal (KM&EL), 4*(3), 310-324.

Qureshi, Q. A., Nawaz, A., & Khan, N. (2011). Prediction of the problems, user-satisfaction and prospects of e-learning in HEIs of KPK, Pakistan. *International Journal of Science and Technology Education Research, 2*(2), 13-21.

Rahman, T. (2014). The Internet, Youth and Education in Pakistan.

Rashid, P. M. (2010). *Developing the Strategy for Quality Assurance of Open and Distance Learning in Pakistan: The Higher Education Perspective*. Paper presented at the 3rd International Conference on Assessing Quality in Higher Education, Lahore-Pakistan.

Robertson, I. (2008). *Sustainable e-learning, activity theory and professional development.* Paper presented at the Ascilite.

Rodriguez-Repiso, L., Setchi, R., & Salmeron, J. L. (2007). Modelling IT projects success: Emerging methodologies reviewed. *Technovation, 27*(10), 582-594.

Rosenthal, R., & Rosnow, R. L. (1991). *Essentials of behavioral research: Methods and data analysis* (Vol. 2): McGraw-Hill New York.

Rourke, L., & Anderson, T. (2002). Using Web-Based, Group Communication Systems To Support Case Study Learning at a Distance. *International Review of Research in Open and Distance Learning, 3*(2), n2.

Rudolf, A., & Pirker, R. (2000). *E-business testing: User perceptions and performance issues.* Paper presented at the Quality Software, 2000. Proceedings. First Asia-Pacific Conference on.

Saaty, T. L. (1977). A scaling method for priorities in hierarchical structures. *Journal of mathematical psychology, 15*(3), 234-281.

Saaty, T. L. (1980). The analytic hierarchy process: planning, priority setting, resources allocation. *M cGraw-Hill*.

Saaty, T. L., & Vargas, L. G. (1994). *Decision making in economic, political, social, and technological environments with the analytic hierarchy process* (Vol. 7): Rws Pubns.

Salmeron, J. L., & Herrero, I. (2005). An AHP-based methodology to rank critical success factors of executive information systems. *Computer Standards & Interfaces, 28*(1), 1-12.

Sangi, N. A. (2008). Electronic assessment issues and practices in Pakistan: a case study. *Learning, Media and Technology, 33*(3), 191-206.

Sanjay Kumar Dubey, S. G., Prof. (Dr.) Ajay Rana. (2012). Comparison of Software Quality Models: An Analytical Approach. *International journal of Emerging Technology and Advanced Engineering, 2*(2), 111-119.

Scott, T. (2000). The wired campus. *Business Weekly, 102*.

Selim, H. M. (2007). Critical success factors for e-learning acceptance: Confirmatory factor models. *Computers & Education, 49*(2), 396-413.

Selim, H. M. (2007). E-learning critical success factors: an exploratory investigation of student perceptions. *International Journal of Technology Marketing, 2*(2), 157-182.

Sharma, A., Kumar, R., & Grover, P. (2008). Estimation of quality for software components: an empirical approach. *ACM SIGSOFT Software Engineering Notes, 33*(6), 1-10.

Shee, D. Y., & Wang, Y. S. (2008). Multi-criteria evaluation of the web-based e-learning system: A methodology based on learner satisfaction and its applications. *Computers & Education, 50*(3), 894-905.

Shraim, K., & Khlaif, Z. (2010). An e-learning approach to secondary education in Palestine: opportunities and challenges. *Information Technology for Development, 16*(3), 159-173.

Siddiqui, Z. H. (2007). *Promoting E-Learning in Pakistan: Strategies and Challenges.* Paper presented at the Paper Presented e-Asia Conference and Exhibition Putrajaya Malaysia.

Sife, A., Lwoga, E., & Sanga, C. (2007). New technologies for teaching and learning: Challenges for higher learning institutions in developing countries. *International Journal of Education and Development using ICT, 3*(2).

Storey, M. A., Phillips, B., Maczewski, M., & Wang, M. (2002). Evaluating the usability of Web-based learning tools. *Educational Technology & Society, 5*(3), 91-100.

Sun, P.-C., Tsai, R. J., Finger, G., Chen, Y.-Y., & Yeh, D. (2008). What drives a successful e-Learning? An empirical investigation of the critical factors influencing learner satisfaction. *Computers & Education, 50*(4), 1183-1202.

Tam, M. C., & Tummala, V. (2001). An application of the AHP in vendor selection of a telecommunications system. *Omega, 29*(2), 171-182.

Tashakkori, A., & Teddlie, C. (2010). *Sage handbook of mixed methods in social & behavioral research*: Sage.

Terregrossa, R. A., Englander, F., & Wang, Z. (2009). Why learning styles matter for student achievement in college economics. *Journal for Economic Educators, 9*(1), 16-31.

Tuohey, W. G. (2002). Benefits and effective application of software engineering standards. *Software Quality Journal, 10*(1), 47-68.

Unicef. (2011). Pakistan: Statistics.

Van Der Merwe, A., Maneschijn, D., & Goikoetxea, A. (2006). Guidelines in selecting an e-learning development model.

Vizcaíno, A., García, F., Villar, J. C., Piattini, M., & Portillo, J. (2013). Applying Q-methodology to analyse the success factors in GSD. *Information and Software Technology, 55*(7), 1200-1211.

Wains, S. I., & Mahmood, W. (2008). *Integrating m-learning with e-learning*. Paper presented at the Proceedings of the 9th ACM SIGITE conference on Information technology education.

Wang, W.-T., & Wang, C.-C. (2009). An empirical study of instructor adoption of web-based learning systems. *Computers & Education, 53*(3), 761-774.

Wang, Y.-S., Wang, H.-Y., & Shee, D. Y. (2007). Measuring e-learning systems success in an organizational context: Scale development and validation. *Computers in Human Behavior, 23*(4), 1792-1808.

Watson, D. (2006). Understanding the relationship between ICT and education means exploring innovation and change. *Education and Information Technologies, 11*(3-4), 199-216.

Weaver, D., Spratt, C., & Nair, C. S. (2008). Academic and student use of a learning management system: Implications for quality. *Australasian Journal of Educational Technology, 24*(1), 30-41.

Wilen-Daugenti, T. (2009). *edu: Technology and learning environments in higher education*: Peter Lang.

Williams, J. B., & Jacobs, J. (2004). Exploring the use of blogs as learning spaces in the higher education sector. *Australasian journal of educational technology, 20*(2).

Wixom, B. H., & Todd, P. A. (2005). A theoretical integration of user satisfaction and technology acceptance. *Information systems research, 16*(1), 85-102.

Wong, D. (2007). A critical literature review on e-learning limitations. *Journal for the Advancement of Science & Arts. School of Management & Information Technology, UCSI. Carseland.*

Yoshikawa, H., Weisner, T. S., Kalil, A., & Way, N. (2008). Mixing qualitative and quantitative research in developmental science: uses and methodological choices. *Developmental Psychology, 44*(2), 344.

Yunus, Y., & Salim, J. (2008). *Framework for the Evaluation of E-learning in Malaysian Public Sector from the pedagogical perspective.* Paper presented at the Information Technology, 2008. ITSim 2008. International Symposium on.

Zahedi, F. (1986). The analytic hierarchy process-a survey of the method and its applications. *interfaces, 16*(4), 96-108.

Zona, R. (1999). The Economic Impacts of Unacceptable Web Site Download Speeds: Research Report, http//www. zonaresearch. com.

LIST OF PUBLICATIONS AND PAPERS PRESENTED

Journals

1) Farid, S., Ahmad, R., & Alam, M. (2015). A Hierarchical Model for E-Learning Implementation Challenges using AHP. *Malaysian Journal of Computer Science, 28*(3).
2) Farid, S., Ahmad, R., Niaz, I. A., Arif, M., Shamsherband, S., & Daud Khattak, M. (2015). Identification and prioritization of critical issues for the promotion of e-learning in Pakistan. *Computers in Human Behavior 51*, 161-171.
3) Systematic Literature Review of E-Learning Quality Models (under review)
4) A Sustainable Quality Assessment Model for E-Learning System: A Software Perspective (under review)

Conferences and Seminar

1) Farid, S., Ahmad, R., Niaz, I., Itmazi, J., & Asghar, K. (2014). *Identifying Perceived Challenges of E-Learning Implementation*. Paper presented at the First International Conference on Modern Communication & Computing Technologies (MCCT'14), Nawabshah, Pakistan.

APPENDIX-A: IDENTIFICATION OF E-LEARNING IMPLEMENTATION CHALLENGES FOR HEIS OF PAKISTAN

Dear Sir/Madam,

An open ended list of potential challenges for the implementation of e-learning in Higher Education Institutions (HEIs) of Pakistan has been formulated after reviewing more than 70 published research papers, articles, case studies from various well renowned journals and conferences. Now it is required to sort out this exhausted list of e-learning implementation challenges selecting the most crucial challenge facing by the HEIs of Pakistan.

You are humbly requested to give your comments based on your experience by marking **Not Crucial (=1) to Most Crucial (=5)** mentioning that which challenge is most crucial for the implementation of e-learning for the localized environment of Pakistan. Moreover, if you feel that any challenge or issue is missing, please feel free to add that issue at the end of the list. Scale values assigned to each of the five responses areas;

Level of Agreement	Scale Values
Most Crucial (MC)	5
Crucial (C)	4
Normal (N)	3
Least Crucial (LC)	2
Not Crucial (NC)	1

Thanking you in anticipation for your kind attention and time.

Shahid Farid,
Ph.D. Candidate,
Faculty of Computer Science & I.T.,
University of Malaya, Kuala Lumpur,
Malaysia.
HP: +6017-3960540, +92-333-3298877
shahidfarid@bzu.edu.pk

A.2 Demographics

Date: _____		Place: _____
Name (optional) _____	Designation _____	Organization (optional) _____
Gender: ☐ Male ☐ Female	Age: ☐ 30 to 40 ☐ 41 to 50 ☐ 51 o 60 ☐ Over 60	Area of expertise: ☐ Academia ☐ Research ☐ Software Development ☐ Administration
Qualification ☐ Bachelor ☐ Master ☐ Doctorate		Experience: ☐ Less than 5 years ☐ 5 to 10 years ☐ More than 10 years

A.3 List of Critical Challenges for E-Learning Implementation in Pakistan

No.	Identified Challenge	Level of agreement				
		1	2	3	4	5
1.	Lack of instructional designer					
2.	Lack of instructional design process					
3.	Lack of software quality assurance process					
4.	Bandwidth					
5.	Lack of formal implementation process					
6.	Lack of interest of Faculty					
7.	Lack of ICT enabled teachers					
8.	Lack of ICT enabled students					
9.	Power failure					
10.	Lack of LOs in local language					
11.	Socio-Cultural Norms					
12.	Lack of resources					
13.	Accessibility of Internet broadband					
14.	Access to latest computers					
15.	Borrowed e-learning models					
16.	Lack of leadership					
17.	Change in universities structure					
18.	E-learning environment					
19.	Software interface design					
20.	Support for students					
21.	Support for teachers					
22.	Role of teacher and student					
23.	Learning style					
24.	Cost of mobile internet					
25.	Practical arrangements for practical oriented courses					
26.	Literacy rate					
27.						
28.						
29.						
30.						

APPENDIX-B: A HIERARCHICAL MODEL FOR E-LEARNING IMPLEMENTATION CHALLENGES USING AHP

Dear Sir/Madam,

We have conducted an exploratory study to identify the current issues facing by Higher Education Institutions (HEIs) of Pakistan in the adoption and implementation of e-learning systems. Our study discloses 5 dimensions (software, technical, institution, personal and cultural). These dimensions are details into critical issues in the second level of our proposed framework. Your valuable opinion help us the degree of importance of them.

For this purpose, we are conducting a survey using pair-wise comparison questionnaire which consists of two parts. **1)** to rank the identified dimensions with respect to their importance for the implementation of e-learning systems in HEIs of Pakistan and **2)** the relative importance of the critical issues under the identified respective dimension. Being an e-learning expert, you are humbly requested, to give your view point based on your opinion and experience by marking the appropriate box (from equal importance to extreme importance) as given below;

Intensity of importance	Definition	Explanation
1	Equal importance	Two elements contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one element over another
5	Strong Importance	Experience and judgment strongly favor one element over another
7	Very strong importance	One element is favored very strongly over another, it dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one element over another is of the highest possible order of affirmation
Note: 2,4,6,8 can be used to express intermediate values		

Thanks to you for your attention and time.

Shahid Farid,
Ph.D. Candidate,
Faculty of Computer Science & I.T.,
University of Malaya, Kuala Lumpur, Malaysia.
HP: +6017-3960540, +92-333-3298877
shahidfarid@siswa.um.edu.my

B.2 Demographics

Date: _____		Place: _____
Gender: ☐ Male ☐ Female	Age ☐ 30 to 40 ☐ 41 to 50 ☐ 52 o 60 ☐ Over 60	Designation _____
Area of expertise ☐ Academia ☐ Research ☐ Software Development ☐ Administration	Experience ☐ Less than 5 years ☐ 5 to 10 years ☐ More than 10 years	

B.3. Part-I: Dimensions of Hierarchal Model for E-Learning Challenges in Pakistan

No.	Dimensions A	Extreme Importance	Very strong importance	Strong importance	Moderate importance	Equal importance	Moderate importance	Strong importance	Very strong importance	Extreme Importance	Dimensions B
	← A is important than B						B important than A→				
1	Software										Technical
											Institution
											Personal
											Cultural
2	Technical										Institution
											Personal
											Cultural
3	Institution										Personal
											Cultural
4	Personal										Cultural

B.4. Part-II: Critical Issues Prioritization (Pairwise Comparison)

1. Dimension: Software Development

Quest	Critical Issues	Extreme Importance	Very strong importance	Strong importance	Moderate importance	Equal importance	Moderate importance	Strong importance	Very strong importance	Extreme Importance	Critical Issues
1	Software Interface Design										Lack of instructional design process
											Lack of software quality assurance process
2	Lack of instructional design process										Lack of software quality assurance process

2. Dimension: Technical

1	Bandwidth										Accessibility of Internet broadband
											Cost of mobile internet
											Power failure
2	Accessibility of Internet broadband										Cost of mobile internet
											Power failure
3	Cost of mobile internet										Power failure

3. Dimension: Institution

Quest	Critical Issues	Extreme Importance	Very strong importance	Strong importance	Moderate importance	Equal importance	Moderate importance	Strong importance	Very strong importance	Extreme Importance	Critical Issues
1	Practical arrangements for practical oriented courses										Lack of resources
											Lack of formal implementation process
											Borrowed e-learning models
2	Lack of resources										Lack of formal implementation process
											Borrowed e-learning models
3	Lack of formal implementation process										Borrowed e-learning models

4. Dimension: Personal

1	Lack of interest of Faculty										Lack ICT enabled teachers
											Lack ICT enabled students
2	Lack ICT enabled teachers										Lack ICT enabled students

5. Dimension: Cultural

1	Lack of LOs in local language										Socio-Cultural Norms
											Literacy rate
2	Socio-Cultural Norms										Literacy rate

APPENDIX-C: QUALITY ASSESSMENT MODEL FOR E-LEARNING SYSTEMS: A SOFTWARE PERSPECTIVE

Dear Sir/Madam,

The development of "Quality Assessment Model for E-learning Systems (Software Aspect)" for the Higher Education Institutions of Pakistan has been discussed with experts. As a result of this discussion an exhausted list of quality factors based on Systematic Literature Review is formulated. Now it is required to sort out this exhausted list of quality factors by selecting the best suited factors according to the requirements of Higher Educational Institutions of Pakistani.

You are humbly requested to give your comments based on your experience by marking **Not Crucial (=1) to Most Crucial (=5)** mentioning that which quality factor is essential for the said quality assessment model for the localized environment of Pakistan. Moreover, if you feel that any quality factor(s)/characteristic(s) are missing, please feel free to add that factor at the end of the list. Scale values assigned to each of the five responses areas;

Level of Agreement	**Scale Values**
Most Crucial (MC)	5
Crucial (C)	4
Normal (N)	3
Least Crucial (LC)	2
Not Crucial (NC)	1

Thanks a lot for your kind attention and time.

Shahid Farid,
Ph.D. Candidate,
Faculty of Computer Science & I.T.,
University of Malaya, Kuala Lumpur,
Malaysia.
HP: +6017-3960540, +92-333-3298877
shahidfarid@bzu.edu.pk

C.2 Demographics

Date: _____		Place: _____
Name (optional) _____	Designation _____	Organization (optional) _____
Gender: ☐ Male ☐ Female	Age: ☐ 30 to 40 ☐ 41 to 50 ☐ 53 o 60 ☐ Over 60	Area of expertise: ☐ Academia ☐ Research ☐ Software Development ☐ Administration
Qualification ☐ Bachelor ☐ Master ☐ Doctorate		Experience: ☐ Less than 5 years ☐ 5 to 10 years ☐ More than 10 years

C.3. Exhaustive List of Quality Characteristics for E-Learning System

1. Educational Perspective

Characteristics				
a) Content/Instructional Design Specifying e-learning modules into learning objects (LOs) with corresponding instructional strategy.				
1	2	3	4	5
○	○	○	○	○
b) Delivery Course delivery to learners by mean of some Learning Management System (LMS) like blackboard, MOODLE etc.				
1	2	3	4	5
○	○	○	○	○
c) Evaluation Ability of the institution to evaluate various aspects of its desired output.				
1	2	3	4	5
○	○	○	○	○
d) Instructor/Faculty Faculty feels satisfaction and happiness with teaching online.				
1	2	3	4	5
○	○	○	○	○
e) Institution Current situation of the institution/organization to determine its readiness for e-learning adoption/implementation.				
1	2	3	4	5
○	○	○	○	○
f) Administration Plan and manage the execution of e-learning systems.				
1	2	3	4	5
○	○	○	○	○
g) Learner Learners are successful with e-learning and are typically pleased with their experiences.				
1	2	3	4	5
○	○	○	○	○
h) Cost i. Learner's cost-benefit. ii. Institutions continuously improve services while reducing cost.				
1	2	3	4	5
○	○	○	○	○
i) Access				

All learners who wish to learn online have the opportunity and can achieve success.				
1	2	3	4	5
○	○	○	○	○
j) Learning activities Activities related to pedagogy in an e-learning environment.				
1	2	3	4	5
○	○	○	○	○
k) Personalization The capability of the learning platform to accommodate learner's settings.				
1	2	3	4	5
○	○	○	○	○
l) Services The tools that involve in facilitating and supporting learners during the navigation through the system.				
1	2	3	4	5
○	○	○	○	○
m) Interaction/Co-operation Interaction between learners, learners and instructor and learner and content.				
1	2	3	4	5
○	○	○	○	○
n) Interface (HCI) It involves presentation of the education material and user activity performed during the interaction with the system.				
1	2	3	4	5
○	○	○	○	○

2. Software Perspective

a) Accessibility The degree to which an e-learning system is accessible to as many people as possible.				
1	2	3	4	5
○	○	○	○	○
b) Availability Is the system ready to carry its tasks when learner needs it to be, i.e. is the system is available and operational for use to the learners?				
1	2	3	4	5
○	○	○	○	○
c) Capability Can the product perform valuable functions like completeness, accuracy etc.?				
1	2	3	4	5
○	○	○	○	○
d) Conformance System complies with portability standards.				
1	2	3	4	5
○	○	○	○	○
e) Charisma/Look and feel Is the system capability to glue the learners with it? Like uniqueness, attractiveness, entrancement of the system etc.?				
1	2	3	4	5
○	○	○	○	○
f) Efficiency System should fulfill its purpose without wastage of resources.				
1	2	3	4	5
○	○	○	○	○
g) Modifiability Ability to change the product according to the requirements of learners.				
1	2	3	4	5
○	○	○	○	○
h) Functionality The capability of the software system to provide functions which meets the learners need.				
1	2	3	4	5
○	○	○	○	○
i) Maintainability Can the product maintained and extended at low cost?				
1	2	3	4	5
○	○	○	○	○
j) Portability Transferring of system to another environment.				

1	2	3	4	5
○	○	○	○	○

k) Reliability

Ability of the system not to go failed while running and to work as per requirement. (Can we trust the system in many and difficult situations?)

1	2	3	4	5
○	○	○	○	○

l) Security

Does the e-learning system protect against unwanted access (like authentication, authorization etc.) while still providing the access to people and/or systems that are authorized?

1	2	3	4	5
○	○	○	○	○

m) Usability

Is the product easy to use?

1	2	3	4	5
○	○	○	○	○

n) Inimitability

Uniqueness of the system that it cannot be replicate.

1	2	3	4	5
○	○	○	○	○

o) Re-usability

A segment of source code can be used again to add new functionalities with slight or no modification.

1	2	3	4	5
○	○	○	○	○

p) Extendibility

System's ability to have new functionality extended, in which the system's internal structure and data flow are minimally or not affected.

1	2	3	4	5
○	○	○	○	○

q) Sustainability

Is the system capable to accommodate the changes in the existing environment without compromising on its current operations?

1	2	3	4	5
○	○	○	○	○

r) Interoperability

Is the system capable of exchanging desired information via interfaces of different systems operational in the organization?

1	2	3	4	5
○	○	○	○	○

s) Performance

Ability of e-learning system to meet the timing requirements, e.g. how many transactions can be processed in a minute

1	2	3	4	5
○	○	○	○	○

t) Accuracy Are the results/outputs produced by the e-learning system accurate?				
1	2	3	4	5
○	○	○	○	○
u) Flexibility The capability of the e-learning system to be changed as the requirements of the learner changed.				
1	2	3	4	5
○	○	○	○	○
v) Robustness Is the system able to handle the foreseen and unforeseen errors efficiently and in an appropriate manner?				
1	2	3	4	5
○	○	○	○	○
w) Understandability Is the system's functionalities are easy to understand and operate?				
1	2	3	4	5
○	○	○	○	○
x) Scalability The e-learning system is capable to handle the growth in devices or functionalities in the existing system.				
1	2	3	4	5
○	○	○	○	○

3. Miscellaneous

a) Domain Related

Contents relevancy, granularity, course organization, course depth and breadth etc.

1	2	3	4	5
○	○	○	○	○

b) Emotional Intelligence

Emotions or feelings of learner after using the system, e.g a learner is relax, happy or annoyed (emotions) after interacting with the e-learning system.

1	2	3	4	5
○	○	○	○	○

c) Technical Infrastructure

Establishment of technical infrastructure to commensurate with e-learning activities like bandwidth, speed, cost of internet etc.

1	2	3	4	5
○	○	○	○	○

d) IT-ability

Is the e-learning product easy to install, uninstall, deploy and configure?

1	2	3	4	5
○	○	○	○	○

e)

1	2	3	4	5
○	○	○	○	○

f)

1	2	3	4	5
○	○	○	○	○

g)

1	2	3	4	5
○	○	○	○	○

APPENDIX-D: FACE VALIDITY

D.1. Face Validity

Dear Mr. Shahid Fareed

Hello!

I have filled your questionnaire regarding "quality assessment framework for e-learning systems in software perspective". It is the real need of higher education institutions of Pakistan to improve the quality of their e-learning systems. I was not able to respond you earlier for the face validity of your survey questionnaire due to my tight schedule. your research effort is going to enhance the standard of education in Pakistan.

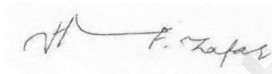
The factors selected in survey instrument are looks fine and relevant. All factors are correlated with each other reflecting the objective of the study. Its division into three categories shows the involvement of all stake holders.

Suggestions:

a) Opinion should be taken from experts, with as much experience as possible, of three mentioned categories.
b) It is better to increase value of Likert Scale.

You can contact me for further suggestions and/or opinion

Regards,



Dr. Hafiz Muhammad Faisal Zafar,
Principal Scientist,
Informatics Complex (PAEC),
Sector H-8, Islamabad.
Contact: 0321 5569912
Email: hmfzafar@gmail.com

Dear scholar,

Thank you for contacting me to participate in your research effort regarding my opinion about the face-validity of survey instrument for "quality assessment framework for e-learning systems (a software perspective)". It is pleasant to know that this effort is going to enrich the ability of higher education institutions of Pakistan in enhancing the quality of their e-learning systems.

After critically analysis of the survey instrument, I would like to highlight some issues to modify appropriately;

a) It will be more beneficial if five point Likert scale values are used instead of only two response options (i.e. Yes and No). As it is possible that it may discriminate the desired results of the survey.
b) Explanation of quality factor 2(n) is ambiguous and needs to clarify.

Opinion:

Questionnaires are consistent and relevant to the title and the formulated objective of the study.

Please feel free to contact me again if you will have any further question or confusion.

Regards,
Dr. Mohammad Daud Khattak,
Director Regional Campus,
Allama Iqbal Open University, Islamabad,
Khyber Pakhtonkhwa, Peshawar.
Contact: 03359831339
Email: daud.khattak@aiou.edu.pk

APPENDIX-E: MEAN VALUES

E.1. Mean Values

Quality Characteristics	Mean Values
Availability	4.04
Usability	4.22
User Interface	4.06
Functionality	4.18
Accessibility	4.00
Security	4.08
Performance	3.98
Reliability	4.22
IT-ability	4.14
Sustainability	4.12

APPENDIX-F: STATISTICS ANALYSIS RESULTS

F.1. Reliability Analysis (Cronbach's Alpha)

Table F.1: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.943	.944	42

F.2. Case Processing Summary

Table F.2: Case Processing Summary

		N	%
Cases	Valid	50	100.0
	Excluded[a]	0	.0
	Total	50	100.0

a. List wise deletion based on all variables in the procedure.

Table F.3: Item Statistics

	Mean	Std. Deviation	N
VAR00001	3.3000	1.19949	50
VAR00002	3.3200	1.23619	50
VAR00003	3.3200	1.18563	50
VAR00004	3.2200	1.21706	50
VAR00005	3.1200	1.22291	50
VAR00006	3.6400	1.20814	50
VAR00007	3.3200	1.01900	50
VAR00008	3.3000	1.12938	50
VAR00009	3.8200	1.18992	50
VAR00010	3.1200	1.00285	50
VAR00011	3.1600	1.14927	50
VAR00012	3.2200	1.13011	50

VAR00013	3.6800	1.20272	50
VAR00014	4.0600	1.05772	50
VAR00015	4.0000	.98974	50
VAR00016	4.0400	1.19455	50
VAR00017	3.4800	1.12920	50
VAR00018	3.2400	1.18769	50
VAR00019	3.6400	1.06445	50
VAR00020	3.6800	1.15069	50
VAR00021	3.3200	1.23619	50
VAR00022	4.1800	1.13731	50
VAR00023	3.4800	1.18218	50
VAR00024	3.4200	1.19676	50
VAR00025	4.2200	1.03589	50
VAR00026	4.0800	1.08496	50
VAR00027	4.2200	1.07457	50
VAR00028	2.6200	1.12286	50
VAR00029	3.1400	1.21235	50
VAR00030	3.7000	1.19949	50
VAR00031	4.1200	.91785	50
VAR00032	3.2800	1.08872	50
VAR00033	3.9800	1.16916	50
VAR00034	3.9200	1.17526	50
VAR00035	3.3000	1.16496	50
VAR00036	3.6400	1.13856	50
VAR00037	4.1800	1.20695	50
VAR00038	3.4600	1.12866	50
VAR00039	3.0000	1.10657	50
VAR00040	3.4800	1.03490	50
VAR00041	4.1400	1.10675	50
VAR00042	2.7000	1.75255	50

Table F.4: Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
VAR00001	145.9600	663.958	.662	.	.940
VAR00002	145.9400	676.874	.434	.	.942
VAR00003	145.9400	677.649	.442	.	.942
VAR00004	146.0400	681.019	.375	.	.943
VAR00005	146.1400	669.143	.564	.	.941
VAR00006	145.6200	667.220	.603	.	.941
VAR00007	145.9400	690.262	.280	.	.943
VAR00008	145.9600	676.284	.490	.	.942
VAR00009	145.4400	672.823	.520	.	.941
VAR00010	146.1400	682.449	.436	.	.942
VAR00011	146.1000	691.969	.215	.	.944
VAR00012	146.0400	685.182	.336	.	.943
VAR00013	145.5800	687.514	.275	.	.943
VAR00014	145.2000	663.837	.759	.	.940
VAR00015	145.2600	667.135	.747	.	.940
VAR00016	145.2200	670.828	.550	.	.941
VAR00017	145.7800	668.093	.633	.	.941
VAR00018	146.0200	668.142	.599	.	.941
VAR00019	145.6200	690.281	.266	.	.943
VAR00020	145.5800	663.636	.698	.	.940
VAR00021	145.9400	672.996	.496	.	.942
VAR00022	145.0800	659.544	.779	.	.940
VAR00023	145.7800	680.216	.401	.	.942
VAR00024	145.8400	674.504	.489	.	.942
VAR00025	145.0400	674.651	.569	.	.941
VAR00026	145.1800	672.191	.586	.	.941
VAR00027	145.0400	666.243	.702	.	.940
VAR00028	146.6400	690.929	.239	.	.943
VAR00029	146.1200	672.026	.522	.	.941
VAR00030	145.5600	673.639	.502	.	.942

VAR00031	145.1400	676.572	.605	.	.941
VAR00032	145.9800	689.693	.270	.	.943
VAR00033	145.2800	658.532	.774	.	.940
VAR00034	145.3400	667.862	.610	.	.941
VAR00035	145.9600	669.753	.584	.	.941
VAR00036	145.6200	669.751	.599	.	.941
VAR00037	145.0800	663.381	.667	.	.940
VAR00038	145.8000	672.000	.565	.	.941
VAR00039	146.2600	673.747	.546	.	.941
VAR00040	145.7800	681.522	.439	.	.942
VAR00041	145.1200	672.924	.560	.	.941
VAR00042	146.5600	662.007	.457	.	.943

Table F.5: Scale Statistics

Mean	Variance	Std. Deviation	N of Items
149.2600	706.319	26.57666	42

F.2. Principal Component Analysis

Eigenvalue	13.700	3.185	2.781	2.285	2.103	1.825	1.654	1.555	1.354
Proportion	0.	0.	0.	0.	0.	0.	0.	0.	0.
Cumulative	0.326	0.402	0.468	0.523	0.573	0.616	0.656	0.693	0.725

Eigenvalue	1.268	1.077	1.001	0.897	0.837	0.807	0.677	0.587	0.494
Proportion	0.	0.	0.	0.	0.020	0.019	0.016	0.014	0.012
Cumulative	0.755	0.781	0.804	0.826	0.846	0.865	0.881	0.895	0.907

Eigenvalue	0.434	0.406	0.391	0.365	0.315	0.293	0.253	0.229	0.198
Proportion	0.010	0.010	0.009	0.009	0.007	0.007	0.006	0.005	0.005
Cumulative	0.917	0.927	0.936	0.945	0.952	0.959	0.965	0.971	0.975

Eigenvalue	0.175	0.159	0.129	0.116	0.100	0.067	0.060	0.054	0.042
Proportion	0.004	0.004	0.003	0.003	0.002	0.002	0.001	0.001	0.001
Cumulative	0.980	0.983	0.986	0.989	0.992	0.993	0.995	0.996	0.997

Eigenvalue	0.040	0.033	0.026	0.012	0.010	0.007
Proportion	0.001	0.001	0.001	0.000	0.000	0.000
Cumulative	0.998	0.999	0.999	1.000	1.000	1.000

Table F.6: Proportions of extracted quality characteristic using PCA

S.No	Factors	Proportion
1	Availability	0.326
2	performance	0.076
3	usability	0.066
4	functionality	0.054
5	security	0.05
6	reliability	0.043
7	itability	0.039
8	user interface	0.037
9	accessibility	0.032
10	accuracy	0.03
11	sustainability	0.026
12	efficiency	0.024

Table F.7: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	13.700	32.620	32.620	13.700	32.620	32.620
2	3.185	7.582	40.202	3.185	7.582	40.202
3	2.781	6.622	46.824	2.781	6.622	46.824
4	2.285	5.440	52.264	2.285	5.440	52.264
5	2.103	5.006	57.270	2.103	5.006	57.270
6	1.825	4.346	61.616	1.825	4.346	61.616
7	1.654	3.938	65.553	1.654	3.938	65.553
8	1.555	3.703	69.256	1.555	3.703	69.256
9	1.354	3.224	72.481	1.354	3.224	72.481
10	1.268	3.019	75.499	1.268	3.019	75.499
11	1.077	2.563	78.062	1.077	2.563	78.062
12	1.001	2.384	80.446	1.001	2.384	80.446
13	.897	2.135	82.582			
14	.837	1.994	84.576			
15	.807	1.922	86.498			
16	.677	1.612	88.110			
17	.587	1.399	89.508			
18	.494	1.175	90.684			
19	.434	1.033	91.716			
20	.406	.968	92.684			
21	.391	.931	93.615			
22	.365	.868	94.483			
23	.315	.750	95.233			
24	.293	.698	95.931			
25	.253	.601	96.532			
26	.229	.545	97.077			
27	.198	.471	97.549			
28	.175	.417	97.966			
29	.159	.378	98.343			
30	.129	.307	98.650			

31	.116	.276	98.925			
32	.100	.239	99.164			
33	.067	.159	99.324			
34	.060	.143	99.467			
35	.054	.128	99.595			
36	.042	.100	99.695			
37	.040	.095	99.790			
38	.033	.079	99.869			
39	.026	.061	99.930			
40	.012	.029	99.959			
41	.010	.023	99.983			
42	.007	.017	100.000			
Extraction Method: Principal Component Analysis.						

Table F.8: Component Matrix[a]

	1	2	3	4	5	6	7	8	9	10	11	12
VAR00022	.829											
VAR00033	.809							-.385				
VAR00015	.806											
VAR00014	.795			.402								
VAR00027	.745	-.344										
VAR00037	.720											
VAR00020	.713									.317		
VAR00001	.662	.314	-.431									
VAR00031	.655		.397									
VAR00026	.653	-.435										-.352
VAR00017	.650			.311					-.376			
VAR00034	.640						.330					
VAR00036	.627		.331									-.415
VAR00016	.623							-.361				
VAR00041	.620	-.452		-.327								
VAR00006	.619										.432	
VAR00025	.616			.324				-.395				
VAR00038	.611											
VAR00035	.606					-.450						
VAR00018	.598		.310		.306					.341		

VAR00005	.585		-.463	-.308								
VAR00009	.572											
VAR00039	.567				.536							
VAR00008	.540		-.329					.413				
VAR00029	.527						.308	.380				
VAR00024	.509		.482									
VAR00021	.502	.339	.305			.483						
VAR00040	.497	-.335		-.357								
VAR00003	.463	.336			-.450							
VAR00010	.454		-.309				.382				-.414	
VAR00002	.451	.407			-.311							
VAR00032		.495			.308	-.369				-.407		
VAR00012	.333	.450		.450			-.379					
VAR00042	.501		-.563									
VAR00030	.557		.557					.356				
VAR00011		.355		-.370					.307		.360	
VAR00019				.498	.574							
VAR00007					.519	.541		-.310				
VAR00013		.405	.307			.439						
VAR00023	.404	.403		-.378			.477					
VAR00004	.379			-.332			-.411					
VAR00028			.355		.442				-.530			
Extraction Method: Principal Component Analysis.												
a.12 components extracted.												

F.3. Logistic Regression

Logistic Regression on Selected Factors

Predictor	Coef	SE Coef	P	Odds Ratio
Constant	68.683	62.2	0.991	
IT-ability	11.1262	2.6	0.056	2.1
Interface (HCI)	30.2639	9.0	0.001	3.12
Accessibility	8.0010	1.3	0.040	1.901
Availability	12.6714	2.4	0.000	5.12
Efficiency	23.8605	63.0	0.198	0.8031
Functionality	15.0991	2.4	0.000	3.4
Reliability	10.4615	2.4	0.020	2.23
Security	20.0216	4.1	0.000	4.01
Usability	16.1375	3.8	0.030	1.745
Sustainability	41.7253	4.4	0.000	3.45
Performance	32.9846	1.6	0.000	4.01
Accuracy	13.7736	2.8	0.060	1.21

Log-Likelihood = -0.000
Test that all slopes are zero: G = 62.687, DF = 13, P-Value = 0.000

Goodness-of-Fit Tests

Method	DF	P
Pearson	35	1.000
Deviance	35	1.000
Hosmer-Lemeshow	8	1.000

Measures of Association:
(Between the Response Variable and Predicted Probabilities)

Pairs	Number	Percent	Summary Measures	
Concordant	544	100.0	Somers' D	1.00
Discordant	130	0.0	Goodman-Kruskal Gamma	1.00
Ties	0	0.0	Kendall's Tau-a	0.44
Total	544	100.0		

F.4 Comparison of Proportions

Number of samples = 10

Sample size = 250.0

Mean proportion = 0.8208

Chi-Square Test

Table F.9: Chi-Square Summary

Chi-square	*Df*	*P-Value*
4.56	9	0.8710

The StatAdvisor

This procedure tests the hypothesis that the mean proportions of the 10 samples are all identical. It also generates an analysis of means (ANOM) plot to determine which samples are significantly different from the grand mean. The chi-square test compares each of the sample values to their grand mean. Since the P-value is greater than or equal to 0.05, there are no significant differences between the samples at the 95% or higher confidence level.

ANOM Report

95% Decision Limits

UDL = 0.89

Centerline = 0.82

LDL = 0.76

Number of samples beyond limits = 0

The StatAdvisor

This report shows the observed proportion for each of the 10 samples. In this case, there are no significant differences amongst the samples at the 95% confidence level.

F.5. Level of Agreement between Stakeholders (Kappa Analysis)

Table F.10: Kappa Analysis results

Academician	Researchers	Admin	SW Developers
1	1	2	3
		Kappa	P-value
IT-ability	1, 2	0.75456	0.000
	1, 3	0.343621	0.32
	2, 3	0.45323	0.214
Interface	1, 2	0.85456	0.000
	1, 3	0.43551	0.1325
	2, 3	0.45323	0.1004
Accessibility	1, 2	0.74	0.000
	1, 3	0.72451	0.000
	2, 3	0.800012	0.000
Functionality	1, 2	0.9	0.000
	1, 3	0.843	0.000
	2, 3	0.856	0.000
Reliability	1, 2	0.94	0.000
	1, 3	0.92134	0.000
	2, 3	0.8585	0.000
Security	1, 2	0.8342	0.000
	1, 3	0.88801	0.000
	2, 3	0.92	0.000
Usability	1, 2	0.7545	0.000
	1, 3	0.6985	0.000
	2, 3	0.7982	0.000
Sustainability	1, 2	0.65467	0.000
	1, 3	0.6951	0.000
	2, 3	0.8545	0.000
Performance	1, 2	0.8976	0.000
	1, 3	0.84325	0.000
	2, 3	0.9453	0.000
Availability	1, 2	0.843	0.000
	1, 3	0.79216	0.000
	2, 3	0.80101	0.000

APPENDIX-G: APPLICABILITY VALIDATION

G.1. A Sustainable Quality Assessment Model for E-Learning Systems (SQAMELS): A Software Perspective

Dear Sir/Madam,

On the basis of data collected from experts regarding the identification of the most crucial quality characteristics for the proposition of Sustainable Quality Assessment Model for E-Learning Systems (SQAMELS) for HEIs of Pakistan. Now it is required to evaluate SQAMELS with respect to its applicability for the localized environment of Pakistan.

You are humbly requested to give your comments based on your experience by marking Strongly Disagree (=1) to Strongly Agree (=5) mentioning that which item of the instrument is applicable for the localized environment of Pakistan. Your kind feedback will help us in validating our framework.

Thanks for your kind attention and support.

Regards,
Shahid Farid,
Ph.D. Candidate,
Department of Software Engineering,
Faculty of Computer Science & I.T.,
University of Malaya, Kuala Lumpur,
Malaysia.

Email: shahidfarid@bzu.edu.pk
Cell: +60-17-3960540

G.2 Demographics

Date: _____		Place: _____
Name (optional) _____	Designation _____	Organization (optional) _____
Gender: ☐ Male ☐ Female	Age: ☐ 30 to 40 ☐ 41 to 50 ☐ 54 o 60 ☐ Over 60	Area of expertise: ☐ Academia ☐ Research ☐ Software Development ☐ Administration
Qualification ☐ Bachelor ☐ Master ☐ Doctorate		Experience: ☐ Less than 5 years ☐ 5 to 10 years ☐ More than 10 years

G.3. Survey Instrument

1. Do you think the SQAMELS reflects the objective of the study?				
1	2	3	4	5
○	○	○	○	○
2. I found the SQAMELS is not complex to adopt for the quality assessment of e-learning systems in Pakistan.				
1	2	3	4	5
○	○	○	○	○
3. Do you think that SQAMELS is not clumsy for the decision makers?				
1	2	3	4	5
○	○	○	○	○
4. Do you think SQAMELS reduces the efforts required for decision making in order to select an appropriate e-system?				
1	2	3	4	5
○	○	○	○	○
5. Do you think that adequate aspects of software perspective are covered in the SQAMELS?				
1	2	3	4	5
○	○	○	○	○
6. Do you think that the framework has the potential to address the future changes and/or requirements of the HEIs of Pakistan?				
1	2	3	4	5
○	○	○	○	○
7. Do you think the framework has potential to be practically implemented in the localized e-learning environment?				
1	2	3	4	5
○	○	○	○	○
8. Overall, I found the framework is useful and easy to measure the quality of e-systems.				
1	2	3	4	5
○	○	○	○	○

APPENDIX-H: UTILITY VALIDATION

H.1. Sustainable Quality Assessment Model for E-Learning Systems (SQAMELS): A Software Perspective

Dear Sir/Madam,

On the basis of data collected from experts regarding the identification of the most crucial quality characteristics for the proposition of sustainable quality assessment model for e-learning systems for HEIs of Pakistan. Now it is required to evaluate the proposed model by examining the quality characteristics and sub-characteristics with respect to its usefulness (utility validation) for the localized environment of Pakistan.

You are humbly requested to give your comments based on your experience by choosing appropriate option mentioning that which item of the instrument is useful for the localized environment of Pakistan. Your kind feedback will help us in validating our model.

Thanks for your kind attention and support.

Regards,
Shahid Farid,
Ph.D. Candidate,
Department of Software Engineering,
Faculty of Computer Science & I.T.,
University of Malaya, Kuala Lumpur,
Malaysia.
Email: shahidfarid@bzu.edu.pk
Cell: +60-17-3960540

H.2. Demographics

Date: _____		Place: _____
Name (optional) _____	Designation _____	Organization (optional) _____
Gender: ☐ Male ☐ Female	Age: ☐ 30 to 40 ☐ 41 to 50 ☐ 55 o 60 ☐ Over 60	Area of expertise: ☐ Academia ☐ Research ☐ Software Development ☐ Administration
Qualification ☐ Bachelor ☐ Master ☐ Doctorate		Experience: ☐ Less than 5 years ☐ 5 to 10 years ☐ More than 10 years

H.3. Survey Instrument

1. Currently HEIs of Pakistan are following any criteria or method for the selection of e-learning system?	Yes	No

2. How do you rate the significance of this study?

Not Significant	Less Significant	Neutral	Significant	Very Significant
○	○	○	○	○

3. The model has positive impact towards implementing e-learning practices in Pakistan.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

4. How do you rate the complexity of the model?

Very Complex	Complex	Normal	Less Complex	Not Complex
○	○	○	○	○

5. It is easy to apply the model by adopting the utilization approach devised for the model?

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

6. The model has the potential to be used by the relevant decision making authorities of HEIs of Pakistan?

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

7. Do you think the future requirements have been addressed by the model?

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
○	○	○	○	○

APPENDIX-I: A SUSTAINABLE QUALITY ASSESSMENT MODEL FOR E-LEARNING SYSTEMS (SQAMELS)

I.1. Post-Task Questionnaire

I am a PhD student in the faculty of Computer Science and Information Technology, University of Malaya, Malaysia. The objective of this study is to gather the opinions of e-learning experts about SQAMELS. It is advisable that before answering the questionnaire, you must examine and implement SQAMELS on LMS of your organization. All the information acquired from this study will be exclusively used for academic purposes. Your participation and Co-operation in this study are greatly appreciated.

Name

Gender

- Male
- Female

Age

Qualification

Designation

Experience

- Less than 5 years
- 5 to 10 years

- Above 10 years

Expertise

1. I found that SQAMELS would reduce the effort required to assess the quality of e-learning systems.

- Strongly Agree
- Agree
- Neutral
- Not Agree
- Strongly Not Agree

2. I found that adequate quality indicators of software perspective are covered in SQAMELS

- Strongly Agree
- Agree
- Neutral
- Not Agree
- Strongly Not Agree

3. I found that the utilization approach of SQAMELS is easy to understand.

- Strongly Agree
- Agree
- Neutral
- Not Agree
- Strongly Not Agree

4. Overall, I found the SQAMELS to be useful in evaluating the quality of e-learning systems in software perspective.

- Strongly Agree
- Agree
- Neutral
- Not Agree
- Strongly Not Agree

5. I found the given process guidelines are clear and easy to understand.

- Strongly Agree
- Agree
- Neutral
- Not Agree
- Strongly Not Agree

6. It would be easy to adapt the SQAMELS to meet the requirements of HEIs regarding quality assessment of their e-learning systems.

- Strongly Agree
- Agree
- Neutral
- Not Agree
- Strongly Not Agree

7. The SQAMELS utilization approach requires minimal training, so HEIs do not need to pay any training fee if they want to assess the quality of targeted e-learning systems using SQAMELS.

- Strongly Agree
- Agree
- Neutral
- Not Agree
- Strongly Not Agree

8. I found the procedure of applying the SQAMELS is simple and easy to use.

- Strongly Agree
- Agree
- Neutral
- Not Agree
- Strongly Not Agree

Submit

APPENDIX-J: LIST OF SOFTWARE QUALITY CHARACTERISTICS

Characteristic	Literature
Accuracy	(Ghezzi, Jazayeri, & Mandrioli, 1991)
Correctness	(McCall, Richards, & Walters, 1977)
Efficiency	(Boehm et al., 1978), (I. ISO, 2001), (Dromey, 1995), (Clements, 2002), (McCall et al., 1977), (Kumar, Kumar, & Grover, 2006), (Sharma, Kumar, & Grover, 2008)
Flexibility	(Ghezzi et al., 1991), (Clements, 2002), (Khosravi & Guéhéneuc, 2004), (McCall et al., 1977)
Functionality	(Grady & Caswell, 1987), (Dromey, 1995), (I. ISO, 2001), (Clements, 2002), (Kumar et al., 2006), (Sharma et al., 2008)
Human engineering	(Boehm et al., 1978)
Integrity	(Ghezzi et al., 1991), (McCall et al., 1977)
Interoperability	(McCall et al., 1977)
Maintainability	(Dromey, 1995), (Ghezzi et al., 1991), (I. ISO, 2001), (Clements, 2002), (McCall et al., 1977), (Kumar et al., 2006), (Sharma et al., 2008)
Modifiability	(Boehm et al., 1978)
Performance	(Grady & Caswell, 1987)
Portability	(Boehm et al., 1978), (Dromey, 1995), (Ghezzi et al., 1991), (Sharma et al., 2008), (I. ISO, 2001), (McCall et al., 1977)
Reliability	(Sharma et al., 2008), (Boehm et al., 1978), (Grady & Caswell, 1987), (Ghezzi et al., 1991), (I. ISO, 2001), (McCall et al., 1977), (Dromey, 1995)
Availability	(Clements, 2002)
Reusability	(Dromey, 1995), (Ghezzi et al., 1991), (Khosravi & Guéhéneuc, 2004), (McCall et al., 1977)

Robustness	(Khosravi & Guéhéneuc, 2004)
Scalability	(Khosravi & Guéhéneuc, 2004)
Security	(Clements, 2002)
Supportability	(Grady & Caswell, 1987)
Testability	(Boehm et al., 1978), (Clements, 2002), (McCall et al., 1977)
Understandability	(Boehm et al., 1978)
Usability	(Dromey, 1995), (Grady & Caswell, 1987), (Ghezzi et al., 1991), (I. ISO, 2001), (Khosravi & Guéhéneuc, 2004), (Kumar et al., 2006), (McCall et al., 1977), (Sharma et al., 2008), (Clements, 2002)