# A quality assessment framework for knowledge management software

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PhD

Keele University

December 2016

# Author’s Declaration

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## SUBMISSION OF THESIS FOR A RESEARCH DEGREE

Degree for which thesis being submitted **PhD Computer Science**

Title of thesis **A quality assessment framework for knowledge management software**

**This thesis contains confidential information and is subject to the protocol set down for the submission and examination of such a thesis.**

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Date of submission: **20th October 2016** Original registration date: **08th November 2010**

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# Abstract

**CONTEXT**: Knowledge is a strategic asset to any organisation due to its usefulness in supporting innovation, performance improvement and competitive advantage. In order to gain the maximum benefit from knowledge, the effective management of various forms of knowledge is increasingly viewed as vital. A Knowledge Management System (KMS) is a class of Information System (IS) that manages organisational knowledge, and KMS software (KMSS) is a KMS component that can be used as a platform for managing various forms of knowledge. The evaluation of the effectiveness or quality of KMS software is challenging, and no systematic evidence exists on the quality evaluation of knowledge management software which considers the various aspects of Knowledge Management (KM) to ensure the effectiveness of a KMS.

**AIM**: The overall aim is to formalise a quality assessment framework for knowledge management software (KMSS).

**METHOD**: In order to achieve the aim, the research was planned and carried out in the stages identified in the software engineering research methods literature. The need for this research was identified through a mapping study of prior KMS research. The data collected through a Systematic Literature Review (SLR) and the evaluation of a KMSS prototype using a sample of 58 regular users of knowledge management software were used as the main sources of data for the formalisation of the quality assessment framework. A test bed for empirical data collection was designed and implemented based on key principles of learning. A formalised quality assessment framework was applied to select knowledge management software and was evaluated for effectiveness.

**RESULTS**: The final outcome of this research is a quality assessment framework consisting of 41 quality attributes categorised under content quality, platform quality and user satisfaction. A Quality Index was formulated by integrating these three categories of quality attributes to evaluate the quality of knowledge management software.

**CONCLUSION**: This research generates novel contributions by presenting a framework for the quality assessment of knowledge management software, never previously available in the research. This framework is a valuable resource for any organisation or individual in selecting the most suitable knowledge management software by considering the quality attributes of the software.



**KEYWORDS:** Knowledge Management, Knowledge Management Software, Knowledge Management System Software, Quality assessment framework, Software quality

# Acknowledgements

This thesis was completed with the support of a range of people. I am specially thankful to my lead supervisor, Dr Thomas Neligwa, for guiding me towards the successful completion of this research. I have learned so much from you and all that you have taught me will be reflected during my future career. I must also express appreciation for the help and support of my second supervisor, Dr Theocharis Kyriacou, and my previous second supervisor, Prof Pearl Brereton. Feedback given by Prof Barbara Kitchenham, Dr Mahmood Niazi, Dr Charles Day and Prof Peter Andras at various stages of this research is also appreciated. Thanks are also due to all of the others from technical support to administrative staff working in the School of Computing and Mathematics who have helped me in one way or another. I would also like to thank all the participants of the questionnaire survey.

Those people who belong to the scholarly community and my lecturers in Sri Lanka, who have offered advice at various stages of my PhD must also be thanked. I am grateful to all those who have reviewed protocols, early drafts, articles, video tutorials and prototypes. Your efforts are appreciated and your feedback significantly helped.

Thank you too to the doctors and staff at Critical Care Unit and Maternity Unit of the Keele University Hospital for saving my life while I was in a critical condition during the second year of my studies.

I would like to thank my father (who sadly left us during this period) and mother for their love and encouragement. I would be nowhere if I had not had the support and encouragement of my family members. I am very much thankful to my sisters, brothers, sisters-in-law and brothers-in law.

Last but not least, I am thankful to my wonderful husband Ananda, for supporting and encouraging me as we raised our little son Navinu during my period of studies. Finally, thank you to my little prince Navinu for your patience during this period.

# Dedication

To My Mother and Late Father

for Making This Possible

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# List of Acronyms

| | |
|---|---|
| ATs | Assessment Tasks |
| CMS | Content Management System |
| GQM | Goal Question Metric |
| ILOs | Intended Learning Outcomes |
| ISO | International Standard Organisation |
| IS | Information System |
| IT | Information Technology |
| KLE | Keele Learning Environment |
| KM | Knowledge Management |
| KMS | Knowledge Management System |
| KMSS | Knowledge Management System Software |
| QF | Quality Factor |
| QI | Quality Index |
| RQs | Research Questions |
| SLR | Systematic Literature Review |
| TLAs | Teaching and Learning Activities |

# Chapter 1: Introduction

### 1.1 Chapter synopsis and outline

This chapter introduces the problem domain in relation to the quality assessment of knowledge management software. This chapter sets out the background, aim, and objectives of the research, and outlines the research methodology. The novelty of the research and its contribution to the body of knowledge is introduced, and a thesis roadmap and reading guide are then given at the end of the chapter.

The chapter is organised as follows:

- Section 1.2 describes the background of the study.

  The aim and objectives of this research are presented in Section 1.3.

- Section 1.4 describes the research methodology.

- Section 1.5 explains the research contribution.

- Section 1.6 presents the thesis roadmap and reading guide.

### 1.2 Background

Knowledge is a strategic asset to any organisation, due to its usefulness in innovation, performance improvement and gaining a competitive advantage (Bollinger and Smith, 2001, Hoong and Lim, 2012). This asset is embedded in many layers of a firm; as such, it flows through multiple entities within the firm in the form of the best-known methods, the lessons learned from similar experiences, and in documents, routines, systems and methods

(Kulkarni, 2007). In maximising the benefits of this knowledge, the management of its various forms becomes increasingly important (Jasimuddin and Zhang, 2011). Knowledge Management (KM) can be considered as a socio-technical system of tacit and explicit business policies and practices (Halawi et al., 2005) which is crucial to organisational survival. The general objective of KM is to identify and leverage the collective knowledge in an organisation to help it to compete and thrive (Wild et al., 2002). Knowledge Management Systems (KMS) are a class of Information Systems (IS) used to manage organisational knowledge. They are developed in order to support and enhance the processes of creation, storage, retrieval, transfer and application of knowledge. KMSs provide benefits to organisations in terms of implementing mechanisms for collaboration, organisational learning, workflow management, intellectual property management, and document management (Rao, 2012). A KMS is crucial for effective organisational knowledge management (Li et al., 2014).

KM is enabled by the integration of information technology tools, business processes, human or social capital, continuous learning and innovations (Halawi et al., 2005). Information Technology (IT) can be used as an enabler in implementing the available mechanisms for managing knowledge in the modern era of a knowledge economy. KMS Software (KMSS) is a component of KMS which is used as a platform for managing various forms of knowledge in organisations, enabling them to locate, capture and share information seamlessly with their customers, employees and key stakeholders. Other components of KMS include people, culture, organisational practices and structures.

There are many different ways of categorising knowledge management systems. According to Becerra-Fernandez and Sabherwal (2014), knowledge management systems can be categorised into knowledge application systems, knowledge capture systems, knowledge sharing systems, and knowledge discovery systems (Becerra-Fernandez and Sabherwal, 2014). A summary of general KM processes, systems, associated mechanisms and technologies is provided below in Table 1.1.

| **KM processes** | **KM systems** | **Illustrative KM mechanisms** | **Illustrative KM technologies** |
|---|---|---|---|
| Knowledge Discovery | Knowledge Discovery Systems | Meetings, telephone conversations, collaborative creation of documents, employee rotation across departments, conferences, brainstorming retreats, cooperative projects | Databases, web-based access to data, data mining, repositories of information, web portals, best practices and lessons learned, videoconferencing, electronic discussion groups, e-mail |
| Knowledge Capture | Knowledge Capture Systems | Models, prototypes, best practices, lessons learned, learning by doing, on-the-job training, learning by observation, face-to-face meetings | Expert systems, chat groups, best practices, lessons learned databases, computer-based communication, AI-based knowledge acquisition, computer-based simulations |
| Knowledge Sharing | Knowledge Sharing Systems | Employee rotation across departments, conferences, brainstorming retreats, cooperative projects, memos, manuals, letters, presentations | Videoconferencing, electronic discussion groups, e-mail, team collaboration tools, web-based access to data, databases and repositories of information, best practices databases, lessons learned systems, expertise locator systems |
| Knowledge Application | Knowledge Application Systems | Traditional hierarchical relationships in organisations, help desks, support centres, organisational policies, work practices, standards | Capture and transfer of experts' knowledge, troubleshooting systems, case-based reasoning systems, decision support systems, expert systems, enterprise resource planning systems, management information systems |

Table 1.1 KM processes, systems, associated mechanisms and technologies (Becerra-Fernandez and Sabherwal, 2014)

Furthermore, the distinction between tacit and explicit dimension of knowledge is considered in categorising KMS. Accordingly, considering knowledge in tacit versus explicit dimensions, KMS can be classified into three categories: dynamic systems, process-oriented systems and integrative systems (Benbya and Belbaly, 2005). Classification of KMS in to these three categories, their objectives and examples are summarised in Table 1.2.

| Class | Objectives | Examples |
|---|---|---|
| Dynamic systems | Locate knowledge carriers and seekers, create a social forum, access to experts, support cross functional teams, provide cross-skills set for projects | Expert networks, communities of practice, yellow pages |
| Process oriented systems | Capture knowledge for reuse in solving recurring problems, improve processes | Best practices, process descriptions databases, knowledge repositories |
| Integrated systems | Integrate knowledge source and provide a single point of access | Corporate portal, extranet portals, intranet portals |

Table 1.2 KMS classification and examples (Benbya and Belbaly, 2005)

Another method of classifying KMS is categorising them according to the knowledge management process they mainly support (creation, storage, transfer and application) (Alavi and Leidner, 2001, Tiwana and Ramesh, 2001). Similarly, method of categorising KMS by considering the unique static as well as dynamic properties of knowledge and KM processes which include knowledge extraction, codification, retrieval, distribution, and personalisation is described in (Rao, 2012). A range of KM tools that can be deployed to enable processes, such as knowledge discovery, search, visualization, and collaboration and a list of sample vendors for each tool type are illustrated in Table 1.3.

| KM processes | IT-enabled tools | Sample vendors |
|---|---|---|
| Knowledge creation | Business intelligence, knowledge discovery, e-learning | Business Objects, Skillsoft, Orbital, |
| Knowledge codification | Content management system, document management, categorisation, abstracting, taxonomy | Interwoven, Autonomy |
| Knowledge retrieval | Search, visualization | AskJeeves, Google, lnktomi, lnxight |
| Knowledge application | Workflow, collaboration, help desk | eRoom, lntraspect, Peoplelink |

| | | |
|---|---|---|
| Knowledge distribution | Knowledge portal, agents | Plumtree, AskMe |
| Knowledge validation | Online expert communities, contribution valuation, assessment/rating/ranking/ scoring | IBM |
| Knowledge tracking (of human experts) | E-mail mining, corporate yellow pages | Tacit |
| Knowledge personalization | Expertise locators, communication, conferencing, collaboration | AskMe |
| Full-spectrum KM | Complete KM suites | Hummingbird, OpenText, Verity, IBM |

Table 1.3 IT Tools for KM Processes (Rao, 2012)

As discussed above, it is evident that tools for KMS should be selected for any organization by considering the processes as well as the types of knowledge to be stored and processed. Knowledge creation is a key process supported by knowledge management software which has learning as the core function for managing knowledge.

Many open-source (e.g. Moodle, Claroline and ATutor) as well as commercial (e.g. Microsoft Office 365, Lotus Notes, BlackBoard and Google Apps) KMS software are available. The use of online course management software in a university is an example of KMS software at work in an organisation. For example, Keele Learning Environment (KLE), a KMS software platform developed using BlackBoard, is accessed by employees and students at Keele University (KLE, 2015); it offers a wide range of tools which support teaching and learning and enable the online delivery of lecture notes, assessment, grade books, surveys, quizzes, portfolios, and calendars, and communication through announcements, discussion boards, chat, e-mail and links to social media. Similarly, organisations across different sectors (e.g. health, education, manufacturing, and marketing) use the tools and features of KMS software to manage the knowledge which is crucial to carrying out their day to day activities, as well as in identifying innovative approaches through which to achieve organisational success.

Increasing the effectiveness of KMS software has become one of the most important issues for managing knowledge and competitive advantage in organisations, both in practical and theoretical terms (Rao, 2012, Alavi and Leidner, 2001). In order to measure the effectiveness of KMS software, an appropriate means of measurement must first be identified. Quality is considered to be one of the most useful parameters in measuring the effectiveness of any system, but it is a complex issue and many definitions of quality have been given. Gillies (1997) stated that the ultimate goal of manufacturing any product is to satisfy the users of the product and to realise the benefits expected from it; there is therefore a close relationship between the users of a product and its perceived quality. The IEEE defines quality as "The degree to which a system, component, or process meets specified requirements and customer or user needs or expectations" (IEEE, 1991). Meanwhile, the ISO defines quality as: "The totality of features and characteristics of a product or service that bear on its ability to satisfy specified or implied needs" (ISO-9126, 1991).

The above-cited definitions of the term quality make clear that quality is related to a product's "fitness for purpose", "meeting specifications" and "satisfying customers or users". Accordingly, quality can be defined in terms of the technical properties of the artefact, such as its maintainability and usability, as well as from the perspective of the user, i.e. are the users satisfied with the artefact, and does it address their needs and help them to work more effectively? In general, there are two main views of quality: one is a technical view and the other is a people-oriented view (Garvin, 1984). The former focuses on the product and processes, while the technical perspective is primarily concerned with increasing the rigour of the development process in order to make the product more robust and maintainable. This latter perspective of quality is reflected in software engineering. On the other hand, the user-oriented view focuses primarily on the satisfaction of users and on how useful the artefact is to them in its context of use.

A more complex analysis of the concept of quality is provided by Garvin (1984). Garvin proposes five perspectives of quality in various domains; these are outlined below.

- Technical Views

  *The transcendent view*: a view of quality that can be recognised but not defined.

  *The product-based view*: a view where quality inherits the characteristics of the product.

  *The manufacturing view*: a view measuring quality in terms of conformance to requirements.

- People-oriented views

  *The user-based view*: a view which can be summarised as "fitness for purpose".

  *The value-based view*: a view which measures the ability to provide what the customer requires at a price that they can afford.

Among the three technical views set out above, the manufacturing view of quality is the most commonly employed by software engineers, and lies at the heart of the sequential development methodologies of the traditional waterfall type (Gillies, 1997). Garvin comments that of the two people-oriented views, the user-based definition is more established and has often been sacrificed in the past in favour of assessing the technical attributes of a product (Garvin, 1984).

Due to the role which software plays in modern-day business and living, software quality has received much attention in both academia and business. KMS software plays a vital role in modern organisations and for individuals in carrying out their day-to-day activities, and the quality of KMS software is therefore crucial (Sung-Ho et al., 2004, Anantatmula and

Kanungo, 2010). It has also been emphasised that the usefulness of KMS software and its successful application depend on the quality of its various components (Rao and Osei-Bryson, 2007). Knowledge is what is known, and is a term used to mean the confident understanding of a subject matter, potentially with the ability to use it for a specific purpose (Tiwana, 2000). Knowledge is gained through learning (Henschke and Charungkaittikul, 2011, Alamäki and Mäkinen, 2005). Knowledge is also the central element in the learning process, which consists of the acquisition, integration and exploitation of knowledge (Cohen and Levinthal, 1990). Further, knowledge management has been defined as essentially the creation and application of knowledge as a resource (Grant, 1996).

In order to manage knowledge, learning must be facilitated through KMS software. There are different definitions of learning. An extended definition employed in this research is as follows: “Learning is any experience or event whose outcome (whether or not intended) develops or changes people's knowledge, skills, values or behaviour” (Harrison, 2000). Learning and Knowledge Management go hand in hand, and KMS software provides a platform for learning whose quality is a key parameter of the effectiveness of the learning. Therefore, it is important to identify the KMS software’s quality dimensions, and a systematically designed quality assessment framework plays a vital role in evaluating the effectiveness of learning using KMS software. In this research, quality attributes were identified by considering the learning effectiveness, and software quality were evaluated through a quality assessment framework. The quality attributes of the learning environment were identified by considering the features of the learning environment which had been designed for effective learning. Learning theories (described in Chapter 4) provided the basis for identifying the features of a learning environment using KMS software (Yordanova, 2007).

Throughout the literature review it is evident that KM and e-Learning share some common features (Liebowitz and Frank, 2016, Barker*, 2005, Lau and Tsui, 2009, Chunhua, 2008); they each concern knowledge generation (acquisition, creation, capture and adoption), knowledge storage, knowledge distribution and knowledge application (Wild et al., 2002). In short, e-Learning permits participants to acquire knowledge, pass it from one person to another, apply it to organisational problems/opportunities and store that knowledge for future use. In relating e-Learning to KM, it is apparent that e-Learning is cognitively a part of knowledge sharing and therefore forms a part of KM (Peter Donker, 2002). Therefore, the obvious common features in assessing the quality of both e-Learning and KM were taken in to account in developing the research questions in the present study (Yordanova, 2007).

The effectiveness of any system can be evaluated by assessing whether certain quality factors are met by the system using a quality assessment framework (Gillies, 1997). A number of researchers have addressed the issues involved in evaluating information systems and e-Learning systems (e.g. (Nevo et al., 2008, Alkhattabi et al., 2011, Lee et al., 2011, Adeyinka and Mutula, 2010, Bhuasiri et al., 2012, Calisir et al., 2014), by considering various different factors. The quality of the learning environment is one of the most important parameters in measuring the effectiveness of learning; however, most evaluation frameworks focus on the quality of the software rather than that of the learning environment. Furthermore, an initial mapping study carried out as part of the present research found evidence of a lack of prior research on the learning effectiveness and quality assessment of KMS, particularly in relation to KMS software and e-Learning environments. The present research therefore aims to fill the gap in research with regard to the quality assessment of KMS software (N.B. the term 'knowledge management software' is used throughout this thesis interchangeably with 'KMS software'. In the market, KMS software is also known as a KMS platform. The KMS software prototype developed in this research is named a KMSS prototype).

### 1.3 Aim and objectives

The importance of research of this nature and the significant lack of prior research into the quality assessment of knowledge management software has been identified as described in the background section of the thesis. The overall aim of this research is to devise a quality assessment framework for knowledge management software. The aim of this research was achieved through meeting the seven objectives mentioned below.

1. <u>Examine the existing research on KMS</u>

   In order to identify the topics in KMS which have been investigated by researchers and the potential for conducting research of this kind, a mapping study was conducted. Specifically, for a detailed analysis of the existing research on the quality assessment of KMS, a Systematic Literature Review (SLR) was conducted. In order to achieve this objective, five research questions (RQs) were identified, which are set out below.

   RQ1: Which topics have been investigated by researchers working on Knowledge Management Systems (KMS) or e-Learning Systems?

   RQ2: What does quality mean in relation to KMS or e-Learning Systems?

   RQ3: What are the quality attributes of a KMS or e-Learning software?

   RQ4: What methods are used in assessing quality in KMS or e-Learning software?

   RQ5: How is learning effectiveness measured in KMS or e-Learning systems?

2. <u>Review of learning theories to use as the basis for creating a learning environment in the prototype of KMSS</u>

Knowledge is gained through learning, so one of the crucial functions for managing knowledge is learning. Learning theories provide the basics of learning and insight into what factors make people learn most effectively. The effectiveness of learning is reflected through the quality of the learning environment in which a KMS operates. In this research, the quality attributes of knowledge management software identified through the SLR were validated through empirical data collection. A test bed for data collection was developed using a selected KMS platform, and the results of a review of learning theories were used as the guiding principles for designing a learning environment in the prototype of KMSS.

3. Qualitative selection of a KMS platform for designing a prototype of KMSS

This research used two main sources of data on the quality aspects of knowledge management software, i.e. SLR and empirical data. Empirical data on the quality features of knowledge management software were collected from regular users of knowledge management software. For this purpose, a KMS platform which reflects the quality attributes identified through SLR had to be selected from among the most widely-used platforms. It was not possible to select a KMS platform with all the quality attributes identified through the SLR. Therefore, a test bed was developed as a KMSS prototype using a selected KMS platform. In order to select a KMS platform with the necessary tools and features to reflect the quality attributes identified through the SLR, a qualitative selection of a KMS platform was carried out. For this comparison, 15 widely-used commercial and open-source KMS platforms were considered. The test bed for data collection was developed using the selected KMS platform.

4. Designing and implementing a prototype of KMSS to use as a test bed for data collection

   A KMSS prototype was designed to test the quality attributes identified through the SLR. The learning principles identified through objective two of this study were used as the basics in designing a KMSS prototype which would enable effective learning.

5. Empirical data collection for evaluating quality attributes of a prototype of KMSS

   The data collection methods used for evaluating the quality attributes of KMS software identified through the SLR (RQ4 of the SLR) were applied for the empirical data collection in this research. A sample of 58 regular users of KMS software was selected from two geographic locations for this data collection. The learning activities designed in the KMSS prototype were given to the selected sample of participants to carry out using the KMSS before their evaluation of the quality attributes through a questionnaire survey.

6. Formalisation of the quality assessment framework for knowledge management software

   Based on the data collected through the SLR and via the empirical data collection, a quality assessment framework was formalised. A total of 41 quality attributes of knowledge management software were placed into three categories of quality attributes: content quality (20), platform quality (13), and user satisfaction (8). A Quality Index was formulated by integrating these three categories of quality attributes together to assess the quality of the knowledge management software.

7. Application and evaluation of the quality assessment framework for knowledge management software

The quality assessment framework formalised in this research was applied to evaluate the quality features of widely-used KMS platforms. The quality assessment framework was validated as a valuable resource for any organisation or individual in evaluating the quality of knowledge management software to select a KMS platform. A sample of evaluators was selected to perform this evaluation, and their perceptions of the usability of the framework were provided through a questionnaire survey. The usability of the quality assessment framework was demonstrated through the results of this questionnaire survey. Suggestions for further improving the framework were also identified based on the evaluators' feedback.

The aim and objectives of this research were achieved through a review of research methods in software engineering. This review provided the background knowledge with which to identify the most suitable research method for the present investigation. In essence, this research was carried out in stages identified as a Systematic Literature Review into KMS, an overview of learning theories, a qualitative selection of KMS software, followed by the design, development and evaluation of a KMS software prototype, then the formalisation of the quality assessment framework, and finally, the application and evaluation of the quality assessment framework for knowledge management software.

## 1.4 Research methodology

This study adopted research methods in software engineering which originated from the social sciences. In order to formalise its quality assessment framework for knowledge management software, the research adopted an empirical approach. A variety of data sources were employed, such as a Systematic Literature Review, and evaluation of a KMSS prototype using a questionnaire survey and the academic performance of KMSS users. The empirical approach is characterised by a combination of qualitative and quantitative approaches to data collection and analysis based on a prior study (Kitchenham et al., 2002). Figure 1.1, below, provides an overview of the combined research approaches adopted in this research. For details of the empirical research design and the quality assessment framework development process, see Chapters 2 and 6.

The current section describes the chapters and sub-sections in the thesis containing information on the stages involved in developing the quality assessment framework for knowledge management software. In the first stage of this research, the aim and objectives of the research were identified (as described in Section 1.3, above). The initial literature review and experts' input were used as the foundation for this stage.

In the second stage, a suitable research methodology was identified after reviewing the research methods employed in software engineering (as described in Chapters 1 and 2). Based on the prior literature on research methods in software engineering, an empirical approach was selected as the most appropriate to achieve the aim and objectives of the research.

In the third stage, as illustrated in Figure 1.1, the data collection was conducted in several stages. Two main sources of data were used in the formalisation of the quality assessment framework: the data collected through the Systematic Literature Review, and in the evaluation of a KMSS prototype using a questionnaire survey. The answers to the five research questions mentioned in section 1.3 of this chapter were arrived at through the SLR. The purpose of survey-based data collection through an evaluation of a KMSS prototype was to validate the data gathered through the SLR. In particular, a questionnaire survey was designed and carried out to gather data on users' perceptions of the quality attributes of the

KMS software identified through the SLR. The process of a questionnaire survey adopted in this research is described in Chapter 2.

Data collection on the evaluation of the KMSS prototype using a questionnaire survey was followed by inviting a sample of regular users of knowledge management software to use the KMSS prototype to carry out given teaching and learning activities. The KMSS prototype which was used as the test bed in this research was designed with the necessary quality attributes as identified through the SLR in order to accurately gather the participating users' perceptions. As has been discussed above learning effectiveness is considered as a crucial feature in assessing the quality of KMS software. Therefore, in designing the KMS software prototype, the essential features of a learning environment were identified based on learning theories (see Chapter 4). The learning environment in the KMS software was designed according to the learning theories, and the KMS software (KMSS) prototype was designed using the KMS platform selected based on a qualitative comparison of commercial and open-source software. A sample of KMS software users was selected and their perceptions of the quality attributes of the KMS software were assessed via their use of the prototype (see Chapter 5). Frequency analysis and the ranking of frequencies were used in the data analysis.

As can be seen in the fourth stage of Figure 1.1, below, the quality assessment framework was formalised. The quality attributes of KMS software as identified through the SLR and validated through the questionnaire survey were then used as the basis for the formalisation of the quality assessment framework, which is described in full in Chapter 6. The Quality Index (QI) was formulated based on a multi-element analysis technique, and was used as a single value parameter to provide an indication of level of quality of KMS software by integrating three different categories of quality attributes (content quality, platform quality, and user satisfaction). The process of calculation of the Quality Index is described in Chapter 6.

In the fifth stage of the research, the quality assessment framework was applied to a range of KMS software by regular users of this type of software. Through this application, the quality assessment framework was validated. Data on the perceptions of the users of the framework were gathered through a questionnaire designed to evaluate the usability of the framework. The criteria for this evaluation were considered to be understandability, and user satisfaction of, the framework (see Chapter 7).

Each stage of this research process is described in detail in the following chapters of this thesis. The quality assessment framework for knowledge management software which was formalised through the above process represents the main contribution of this research.

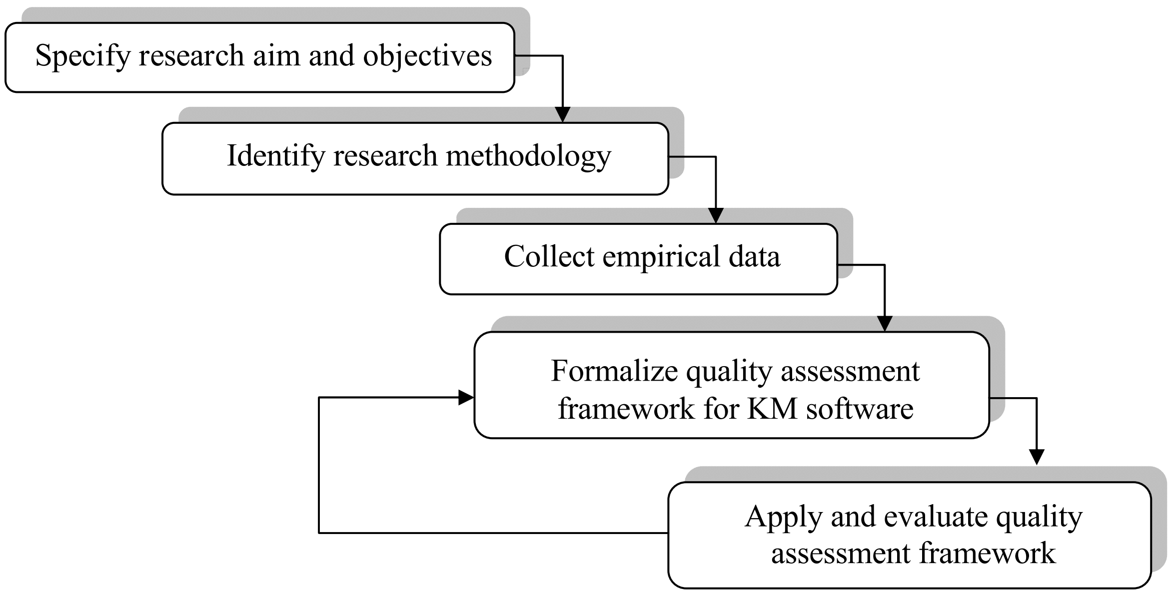


Figure 1.1 Overview of the research approach

## 1.5 Research contribution

Knowledge management is a multi-faceted research area in which a great deal of research has already been undertaken. However, this prior research has predominantly focused on the organisational and human aspects of the subject (Tolen, 1999). Consequently, the technological component of Knowledge Management, particularly KMS software, appears to have been somewhat neglected. Therefore, the motivation for this research stems mainly from the lack of past research undertaken into knowledge management software. In particular, there is a lack of research on quality aspects of knowledge management software, which leads to difficulties for organisations in selecting the right knowledge management software for their needs, as they are unable to fully consider the quality aspects of different software options.

This research makes four main contributions to the field of knowledge management as well as to knowledge in software engineering. Firstly, the main contribution of this research is the quality assessment framework for knowledge management software, which was formalised through an innovative and novel approach, and which can be used in the selection of the most suitable knowledge management software by an organisation. Secondly, the Systematic Literature Review conducted in this research is a valuable reference on KM as it represents the first SLR to have been conducted on this topic. Thirdly, the process of devising this framework based on empirical methods in software engineering is of value to researchers carrying out similar research and allows them to look for further ways to improve the framework. Although frameworks and models have been proposed for various aspects of KM, to the best of the present author's knowledge there is no clear evidence of research providing details on the process of devising a quality assessment model or a framework for knowledge management software. Fourthly, the design, implementation and evaluation of a KMSS prototype demonstrate how to integrate quality attributes into real-life applications of KM. Finally, the suggestions for further improving the framework developed in this research have implications for future research in the fields of KM and software engineering. Furthermore, as with any other framework or model, this framework is evolving and experts' reviews which may improve this framework will be appreciated.

### 1.6 Thesis roadmap and reading guide

This thesis is comprised of eight chapters. An overview of each chapter is given below. Figure 1.2 then provides the reading guide for this thesis.

**Chapter 2: Research methodology in software engineering**

This chapter describes the research methodology in the context of software engineering, particularly with regard to the use of research methods originating from the social sciences. It includes outlines of the major stages and activities of this research, and rationales for the research methods and the research design including the sample profile, as well as descriptions of the data collection and analysis processes, the ethical requirements, and the evaluation of the quality assessment framework for knowledge management software.

**Chapter 3: Systematic Literature Review**

This chapter presents the Systematic Literature Review (SLR) that was used as a main source of data in the formalisation of the quality assessment framework for knowledge management software (see Chapter 6). Answers to the five research questions identified in this research were provided by the Systematic Literature Review. The process of performing the SLR, the results at each step of the SLR, and some reflections on conducting it, are each described in this chapter.

**Chapter 4: Overview of learning theories**

Learning is the foundation for managing knowledge, and the learning effectiveness of knowledge management software is a key parameter of quality in relation to knowledge management software. This chapter describes the learning theories used as the guiding principles in designing a KMSS prototype (see Chapter 5). A general overview of learning theories and their applications in this research is also provided in this chapter.

**Chapter 5: Design, implementation and evaluation of a KMSS prototype**

Data collection in the form of the evaluation of the KMSS prototype is the main source of experimental data for the formalisation of the quality assessment framework in this research. This chapter describes the process of choosing a KMS platform upon which to develop a prototype for use as a test bed for this research, as well as the design, implementation and evaluation of the resulting KMSS prototype. A comparison of KMS platforms, why the specific platform was chosen, design and implementation of the KMSS prototype and evaluation of the KMSS prototype are described in this chapter. Data collection through evaluation of the KMSS prototype by a sample of 58 regular users of knowledge management software is presented in this chapter.

**Chapter 6: Formalisation of the quality assessment framework for knowledge management software**

This chapter describes the formalisation of the quality assessment framework based on the results of the SLR (described in Chapter 3) and experimental data collected through evaluation of the KMSS prototype (described in Chapter 5). The formalisation process of the quality assessment framework and the final outcome are presented in this chapter. The quality assessment framework formalised in this research includes 41 quality attributes sorted into content quality, platform quality and user satisfaction categories. A Quality Index, formulated by integrating these three categories of quality attributes, is a valuable measure in the quantitative evaluation of quality of knowledge management software.

### Chapter 7: Application and evaluation of the quality assessment framework for knowledge management software

This chapter describes the application and evaluation of the quality assessment framework described in Chapter 6. A sample of regular users of KMS software was given the framework to use in the quality evaluation of a range of KMS software. This application validated the quality assessment framework. The evaluation of the framework using a questionnaire survey was followed by the application of the framework. The evaluation criteria of the framework were identified using software engineering evaluation techniques. The chapter presents details on the method and the results of the evaluation gathered from the users of the framework, which proved that the understandability and user satisfaction of the quality assessment framework were adequate.

### Chapter 8: Supplementary literature review

The Systematic Literature Review forming part of this research included research published up to December 2011. This chapter reviews the further literature published from January 2012 through to July 2016 following the same procedures as those of the initial SLR described in Chapter 3. The answers to the research questions are also discussed in this chapter.

### Chapter 9: Conclusion and future work

This chapter presents the major conclusions of the research as well as the key contributions it makes to the body of knowledge, and offers some reflections on the research. Finally, the limitations of the research are identified and discussed, and suggestions for future research are made.

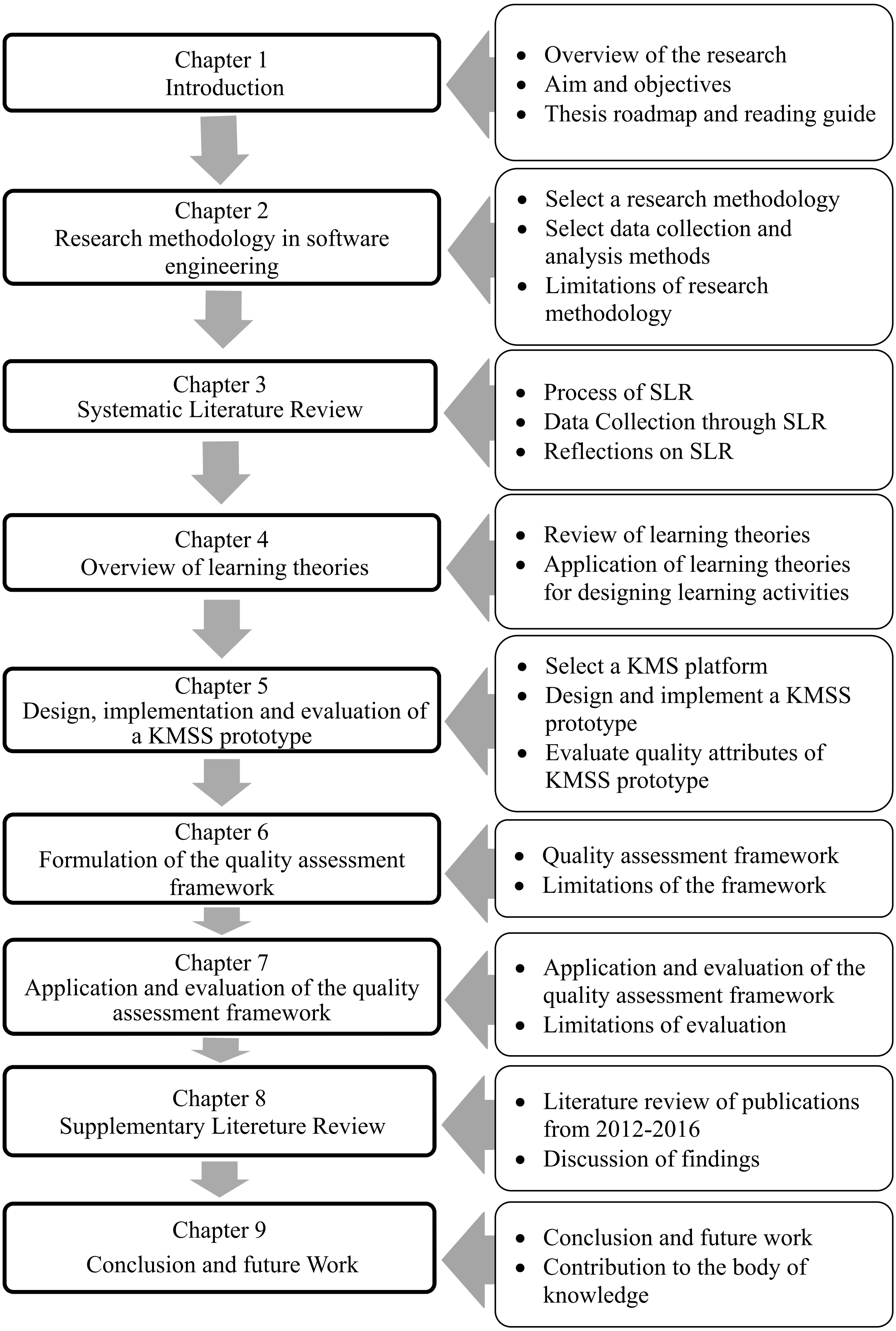


Figure 1.2 Thesis reading guide

# Chapter 2: Research methodology in software engineering

## 2.1 Chapter synopsis and outline

This chapter describes the research methodologies used in software engineering, with particular reference to the use of research methods originating from the social sciences. The research methodologies are examined in order to identify the appropriate research design for the present study which will be able to achieve the research aim and objectives set out in Chapter 1. This chapter describes the major stages and activities of this research and offers the rationales for the research methods and the research design. It also describes the data collection, sample profile, data analysis, and evaluation of the quality assessment framework for knowledge management software. Finally, Keele University's ethical requirements are explained before a summary of the chapter is presented.

The chapter is organised as follows:

- In Section 2.2 the process of selecting a suitable research method is described, along with a justification for the chosen method.
- In Section 2.3, the quantitative and qualitative research methods used in this thesis are described.
- Section 2.4 provides a general introduction to empirical research in software engineering.
- Section 2.5 discusses the research design which was adopted. This section also describes the data collection methods and the data collection protocol used in the research.

- Section 2.6 describes the data collection process with specific reference to the Systematic Literature Review.
- Section 2.7 describes the questionnaire survey data collection for this research.
- Section 2.8 describes the data collection which involved evaluating the performance of the assessment tasks given to the sample of participants to complete after using the KMS software.
- Section 2.9 describes the application and evaluation of the quality assessment framework.
- Section 2.10 outlines the Keele University ethics requirements.
- In Section 2.11, the limitations of the research design are presented and discussed.
- Finally, Section 2.12 summarises and concludes the chapter.

## 2.2 Choosing a research method

Choosing an appropriate research method is an important decision, as it will affect the results of the research. The methods which are selected for use should reflect the aim and objectives of the research (Brewer and Hunter, 1989, Galliers, 1992), fit the approach to the audience and relate it to experiences (Creswell, 2012). In this research, a Systematic Literature Review (SLR) was employed to provide evidence on the methods that could be used in assessing quality in knowledge management software (from the results of research question 3, as described in Chapter 3).

Three research approaches were considered for this study: quantitative, qualitative and mixed methods. The main focus in quantitative research is on the collection of facts and the study of relationships between sets of facts, which are quantified in order to draw generalisable conclusions (Bryman, 1992). In contrast, qualitative research focuses on understanding people's perceptions of the world and on developing insights, collecting words, observing behaviours, and making interpretations. As Bryman observed: “When quantitative and qualitative research is jointly pursued much more complete accounts of social reality can ensue" (Bryman, 1992). In general, quantitative research is more likely to explore a topic in breadth, while qualitative research is more likely to explore it in depth. Creswell and Garrett stated that: “When researchers bring together both quantitative and qualitative research, the strengths of both approaches are combined, leading, it can be assumed, to a better understanding of research problems than either approach alone" (Creswell and Garrett, 2008). A mixed method is defined as “the incorporation of various qualitative or quantitative strategies within a single project that may have either a qualitative or a quantitative theoretical drive" (Tashakkori and Teddlie, 2003). Thus, combining research methods in software engineering research has been deemed to have significant value (Remus and Wiener, 2010). The major strength of mixed methods designs is that they allow for a research study to develop as comprehensively and completely as possible. When compared with a single method, the domain of inquiry is less likely to be constrained by the method itself. The advantages of using a mixed method research design have been discussed in detail in the literature (Gable, 1994). Further, “Collecting different kinds of data by different sources provides a wider range of coverage that may result in a fuller picture of the problem… It provides a richer, contextual basis for interpreting and validating results” (Kaplan and Duchon, 1988). Researchers have therefore been encouraged to consider a mixed method approach for new studies.

The methods applied in this research are described in Section 2.5, which concerns the research design, and which explains that the chosen methods involve the collection of qualitative data through SLR and the evaluation of a KMSS prototype through a questionnaire survey. A questionnaire survey was chosen in order to validate the data collected by the SLR on the quality attributes of knowledge management software. These methods were selected by carefully considering the strengths and weaknesses of different quantitative and qualitative methods.

### 2.3 Quantitative and qualitative research methods

Empirical research in software engineering is concerned with the scientific measurement, both quantitative and qualitative in nature, of software engineering processes and products (Jeffery and Scott, 2002). To be more precise, "Quantitative research use data that can be represented in the form of numbers or that can be immediately transported into numbers. In qualitative research, data then are represented as words and pictures, rather than numbers" (Ma, 2009). In all cases, the choice of approach must be linked to the research objectives. Due to the nature of the data which had to be collected and analysed in order to reach the objectives of this research, both quantitative and qualitative methods were used. Further, the selection of suitable research methods in this research was based on the answer to research question: "RQ4: What are the methods of assessing quality in KMS or e-Learning software?" which emerged from the literature review described in Chapter 3. According to the findings of the literature review, the most common qualitative research methods in software engineering include case studies, observation (participant and non-participant), informal interviews, and thinking aloud. Quantitative research methods include content analysis, questionaire surveys, experiments, and the use of secondary data.

### 2.3.1 Quantitative research methods

Quantitative research is a research strategy that emphasises quantification in the collection and analysis of data. The main concerns of quantitative research methods are that the measurements they make are reliable, valid and generalisable in their clear prediction of cause and effect (Cassell and Symon, 1994). The questionnaire survey is the most commonly-used quantitative data collection method due to its advantages ( e.g. ability to collect large amount of data from a large number of participants in a short time, ability to quantify easily, and ability to analyse more scientifically and objectively) over other methods of data collection, and is frequently used in all phases of software development and evaluation (Reiterer and Oppermann, 1993). More details of the questionnaire survey in this research are provided in Section 2.7.

### 2.3.2 Qualitative research methods

Qualitative research was developed in the social sciences, as an approach enabling researchers to investigate social and cultural phenomena. Researchers who use data other than numbers, such as text and images, refer to their research as being qualitative. Qualitative research can yield complex data and can be difficult to analyse and to draw conclusions from. The conclusions that are arrived at can be interpreted differently by different people, leading to the potential for more criticism than is the case for quantitative research results.

## 2.4 Empirical research in software engineering

Empirical research is defined as "the information, knowledge and understanding gathered through experiences and direct data collection" (Black, 1999). It is based on observation and experiences, and is therefore deemed to reflect the world more fully than other research approaches (Harrison et al., 1999). Since it is based on gathered data, it derives knowledge from actual experience rather than from theory or belief. Empirical approaches have been used in numerous fields, such as medicine, social sciences, education and psychology, but have not yet gained significant recognition in the software engineering research community (Seaman, 1999). Activities in software engineering research typically fall into one of three categories (Jeffery and Scott, 2002):

- To invent new phenomena;
- To understand existing phenomena; and
- To facilitate inspirational education.

Empirical methods were chosen for use in this research in order to address all three aspects of software engineering research listed above. Empirical research can be conducted not only through the use of formal experiments, but also in the form of case studies, surveys and prototyping exercises (Perry et al., 2000). In this research, empirical research was conducted as a prototyping exercise and through a survey. In general, empirical research can sometimes be difficult to conduct due to time constraints, but it also has many advantages including the following: knowledge is encoded more rapidly; low-payoff or erroneous research ideas are discarded quickly; high-payoff areas are recognised and correctly valued; and important practical issues are considered (Perry et al., 2000). The prior literature has provided evidence on the immaturity of the empirical research in software engineering and the need for more consideration in conducting empirical research in software engineering (Sjoberg et al., 2007). In order to address the difficulties associated with conducting and designing an empirical research study, the guidelines offered by a prior study (Kitchenham et al., 2002) were adhered to in this research.

The present research was carried out after conducting a mapping study of the topics under investigation by researchers examining KMS (see Research Question 1, mentioned in Section

1.3 in Chapter 1). The findings of this mapping study, revealed a lack of empirical research on the quality assessment of knowledge management software (results to the RQ1 presented in Section 3.3.3 in Chapter 3 indicated the lack of publications on categories related to quality aspects of knowledge management software). Therefore, it was believed that adopting an empirical research approach could provide new and valuable insight into the research on quality assessment of knowledge management software.

The results of empirical research can be used to define the requirements for the development of novel software tools and techniques, to provide useful insights for the improvement of software engineering in real-world practice and to generate new theories or hypotheses, subject to controlled experimental validation (Lethbridge, 2005). This research does all these things. Firstly, the major contribution of this research is a quality assessment framework for knowledge management software, which is formalised and then validated based on empirical data. This framework is devised based on a Systematic Literature Review and the evaluation of a KMSS prototype using a questionnaire survey which regular users of knowledge management software completed. Secondly, the clearly stated methodology used in devising this framework is provided along with the protocol developed in advance for the empirical data collection. This protocol will be useful for other software engineering researchers in collecting their own empirical data related to knowledge management software. Thirdly, this research is exploratory in nature, as very little evidence was found in the literature on the topic of quality assessment frameworks for knowledge management software.

## 2.5 Research design

The research design is the most important part of any research, as it affects both the process and the final outcomes of the research. The four main questions which must be addressed by a research design, particularly with regard to the data collection and analysis methods are as follows (Punch, 1998): *"Research design situates the researcher in the empirical world and connects the research questions to data ... [It] is the basic plan for a piece of research and includes four main ideas. The first is the strategy. The second is the conceptual framework. The third is the question of who or what will be studied. The fourth concerns the tools and procedures to be used for collecting and analysing empirical materials. Research design thus deals with four main questions, corresponding to these ideas: the data will be collected (and analysed) following what strategy? Within what framework? From whom? How?"* (Punch, 1998).

Furthermore, the research design provides a framework for the collection and analysis of the required data (Bryman, 2003). Following a detailed analysis of the research methodologies deemed appropriate for this research, a mixed method approach employing a Systematic Literature Review (which was used to build an initial framework) followed by a questionnaire survey (to test the derived framework) and the construction of a Quality Index (to evaluate the framework) were adopted in this research. The overall research design is presented in Figure 2.1, which graphically depicts how the outcomes of this research are to be achieved.

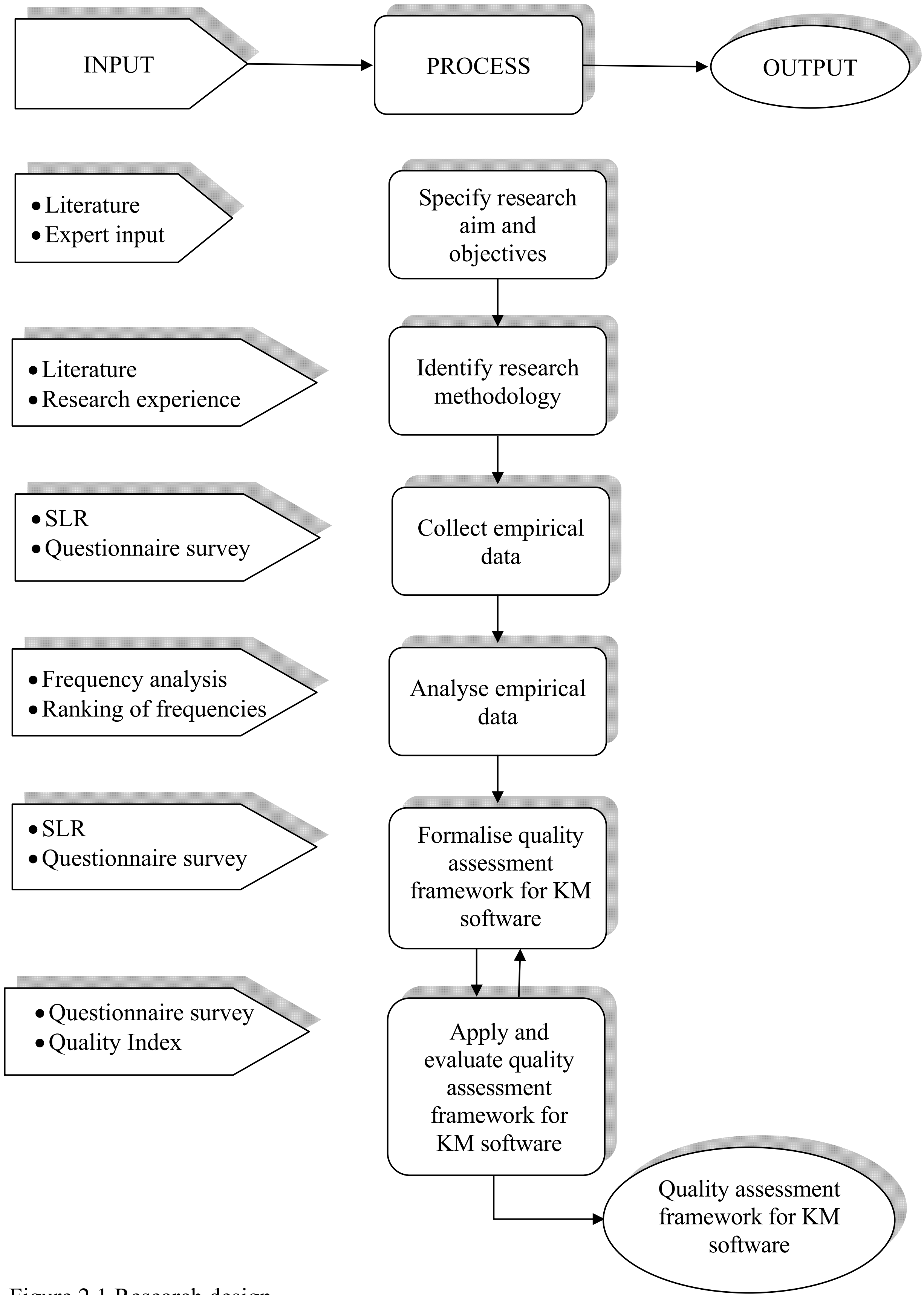


Figure 2.1 Research design

As Figure 2.1 illustrates, an input exists at each stage leading to achieving the final outcome of the research. Identifying an appropriate research methodology (the process described in this chapter) was followed by clearly defining the research aim and objectives (as described in Chapter 1). Empirical data were collected and analysed in the SLR (described in Chapter 3) and by the questionnaire survey (described in Chapter 5), which was used to validate the data gathered through the SLR. The data collection from the questionnaire survey was followed by a review of learning theories (discussed in Chapter 4), and the implementation of a KMSS prototype as a test bed (described in Chapter 5).

As has been discussed, learning is one of the core functions of knowledge management software, and the quality of knowledge management software is reflected through its learning environment. Learning theories were therefore reviewed and used as the basic principles in designing the learning environment of the KMSS prototype, which acted as the test bed for data collection. In order to gather users' perceptions of the quality attributes identified through the SLR and to identify additional quality attributes, a KMSS prototype was designed, developed and implemented in this research, and was evaluated by a sample of regular users of knowledge management software after using the prototype to carry out a set of given learning tasks. Based on the empirical results gathered through the questionnaire survey and the SLR, the quality assessment framework for knowledge management software was formalised and finalised (see Chapter 6). This framework was applied to evaluate the quality attributes of a range of KMS platforms by a sample of evaluators. Its understandability and user satisfaction was evaluated using a questionnaire given to the participating evaluators (see Chapter 7). Since the SLR of this research was conducted in 2011, a supplementary literature review was conducted to review research during the period from January 2012 through to July 2016. The results of the supplementary literature review is presented in Chapter 8. Finally, a conclusion and suggestions for future work based on the findings of this research are presented at the end of the thesis, in Chapter 9.

### 2.5.1 Data collection methods

Data collection can be challenging in empirical research, so the data collection method should be chosen with the context of the research goals or questions in mind (Lethbridge et al., 2005). The selection of data collection methods also depends on the qualitative and quantitative nature of the data to be collected, and using an appropriate data collection method from the various available options will ensure the validity, reliability and feasibility of the data being collected (Bryman, 2003).

For this research, empirical data were gathered in three stages. Firstly, for the identification of the quality attributes of knowledge management software, a Systematic Literature Review (SLR) process was adopted (Kitchenham and Charters, 2007a), which is a defined and methodical way of identifying, assessing and analysing published primary studies in order to investigate a specific research question. Systematic reviews differ from ordinary literature surveys by being formally planned and methodically executed, as they are intended to be independently replicable and so require a different type of scientific value than ordinary literature surveys. In finding, evaluating and summarising all the available evidence on the quality assessment of knowledge management software, a systematic review provided a greater level of validity in its findings than would have been possible in any one of the studies surveyed by it. Section 2.6, below, describes the data collection through the Systematic Literature Review in this study. A Systematic Review Protocol (Appendix 2.2) was initially designed in order to perform the Systematic Literature Review. The process and results of the review are presented in Chapter 3 of this thesis.

Secondly, users' perceptions of the quality attributes of a KMSS prototype were gathered through a questionnaire survey, which is a popular method of data collection in software engineering used to gather data on users' experiences with a software platform. Section 2.7 describes the details of the questionnaire survey.

Learning effectiveness can be evaluated through examining the academic performance of learners, so in addition to the questionnaire survey, data were gathered from an evaluation of the academic performance of users in given assessment tasks. Section 2.8 describes the data collection which in this instance was performed by evaluating the academic performance of users of the KMSS prototype.

Thirdly, data were gathered to evaluate the proposed quality assessment framework by applying it to evaluate the quality attributes of a range of KMS platforms. A sample of regular users of knowledge management software was selected as a group of evaluators to assist this element of the research's data collection. Section 2.9 describes the data collection method used to evaluate a range of KMS platforms using the quality assessment framework designed in this study. These methods were chosen because they were deemed to be well-matched to the nature and type of data that the research wished to collect and analyse (Rockart, 1979). The multiple sources of data mentioned above were then used for data triangulation, which involves taking multiple measures of a studied object, and is relevant in qualitative, quantitative and mixed method studies (Runeson et al., 2012). The findings of this study are strengthened through triangulation, which allows converging lines of enquiry and corroboration. Triangulation also helps to address the potential problem of construct validity (discussed in Section 5 of the data collection protocol given in Appendix 2.1).

### 2.5.2 Data collection protocol

Before the data collection for this research began, a data collection protocol (Appendix 2.1) was developed describing the methods of data collection, the sample selection, and the validation of the data collection methods used in this study. The development of a protocol was helpful to ensure that a reliable, transparent and rigorous study would be performed (Yin, 2009). Furthermore, potential problems were identified and accounted for in advance of implementation. The protocol also acts as a point of reference for other researchers interested in performing similar empirical data collection. The protocol was validated by experts in software engineering research (Prof Pearl Breton, and Dr Mahmood Niazi) before the execution of the data collection. The data collection itself, as set out in the protocol, is described in Chapter 5 of this thesis.

## 2.6 Data collection through a Systematic Literature Review

Systematic reviews aim to synthesise the existing research fairly (without bias), rigorously (according to a defined procedure) and openly (by ensuring that the review procedure is visible to other researchers). The SLR methodology, as explained by a previous study (Kitchenham and Charters, 2007b), has been used to identify the related work in KMS and to investigate how it would apply to this research. There are many reasons for undertaking an SLR; the most common are to summarise the existing evidence concerning a treatment or technology (e.g. to summarise the empirical evidence of the benefits and limitations of a specific agile method), to identify any gaps in the current research in order to suggest areas for further investigation, and to provide a framework/background in order to appropriately position new research activities (Kitchenham and Charters, 2007b).

In finding, evaluating and summarising all the available evidence on the quality assessment of knowledge management software, it was hoped that a Systematic Literature Review (SLR) would provide a greater level of validity in its findings than it might be possible in any one of the studies surveyed using an ordinary literature review, as: “In narrative reviews, the results of the studies tend to form the basis for the conclusions. In contrast, the standard used to draw conclusions from the evidence reported in a SLR is the quality of the methods used to conduct the primary studies (i.e. internal validity, including study design, conduct and analyses)” (CRD, 2001). Systematic reviews improve the reliability of the resulting conclusions due to limiting bias through the use of explicit methods (Mulrow, 1994). The objectives of this SLR were to undertake a systematic review of the literature related to Knowledge Management (KM), to select a sub-set of studies related to KMS and KMS software, to collect and analyse the evidence from these studies in order to assess the need for a quality assessment framework for knowledge management software, and finally to identify the existing tools and mechanisms used in assessing the quality of knowledge management software in order to identify an appropriate methodology for carrying out the proposed research. The process and results of the Systematic Literature Review in this research are presented in Chapter 3.

### 2.6.1 Other reviews

Other types of literature reviews include a systematic mapping study (also known as a scoping study) and a tertiary study (also called a tertiary review). A mapping study is a broad review of primary studies in a specific topic area that aims to identify what evidence is available on the topic (Kitchenham and Charters, 2007b). This allows for the identification of evidence clusters and evidence deserts, which can then direct the focus of future systematic reviews and identify areas in which more primary studies need to be conducted. A mapping study methodology was adopted to answer Research Question 1 of this study, with a view to identifying the topics which have been investigated by prior researchers in the KMS field.

Meanwhile, a tertiary study is a review of secondary studies related to the same research question. As explained in (Kitchenham and Charters, 2007b), “In a domain where a number of systematic reviews exist already it may be possible to conduct a tertiary review, which is a systematic review of systematic reviews”, and a tertiary review can be used to answer wider research questions.

## 2.7 Data collection through a questionnaire survey

Survey research is a method to identify the characteristics of a broad population of individuals (Easterbrook et al., 2008), and is the most common method of data collection because it can be administered quickly and easily. Surveys can be particularly useful in collect meaningful information from a population who have extensive experience of using, or have studied, the method/tools of interest (Kitchenham, 1995). Questionnaires are also frequently used in all phases of software development and evaluation, so in this research, the quality attributes of knowledge management software were assessed using a questionnaire survey. Considering the objectives and available resources in this research, a web-based survey was chosen to gather data from regular users of knowledge management software. Guidelines regarding the conducting of web-based surveys in software engineering research provided by a prior study (Punter et al., 2003) were also followed. The data gathered from the questionnaire survey related to users’ perceptions of the quality features of knowledge management software. This sub-section of the thesis explains the data collection carried out using the questionnaire survey. The main purpose of the data collection using the questionnaire survey in this research was to validate the data collected through the SLR.

### 2.7.1 Stages of a questionnaire survey

The primary stages of the questionnaire survey design process in this research included:

- Constructs operationalisation
- Instrument design
- Sample selection
- Pilot testing
- Conducting the survey
- Data cleansing, and
- Analysis and reporting.

Although these stages are listed sequentially here, the process was largely an iterative one. For example, the sample profile must be known in order to be able to finalise the items and words in the instrument design, and the fundamentals of what is to be measured have to be decided in order to identify the best candidates to respond to the questionnaire survey. Similarly, the data have to be cleaned and codified prior to data analysis, but further data manipulation and codification may also be required as part of the data analysis process. Details of each of the stages in the questionnaire survey process are described in the following sections of the present chapter.

### 2.7.2 Construct operationalisation

Construct operationalisation is the process of identifying constructs and related sub-constructs for each construct, deriving suitable items (survey questions) for each of the sub-constructs, and identifying a suitable measurement scheme (Bryman, 2003). This is a task that is normally iteratively revisited in a questionnaire survey. For an example, selected items may be modified in relation to the feasibility and characteristics of the available sample, or to the results of the pilot testing. Figure 2.2 illustrates the relationship between the key terms used in the construct operationalisation process.

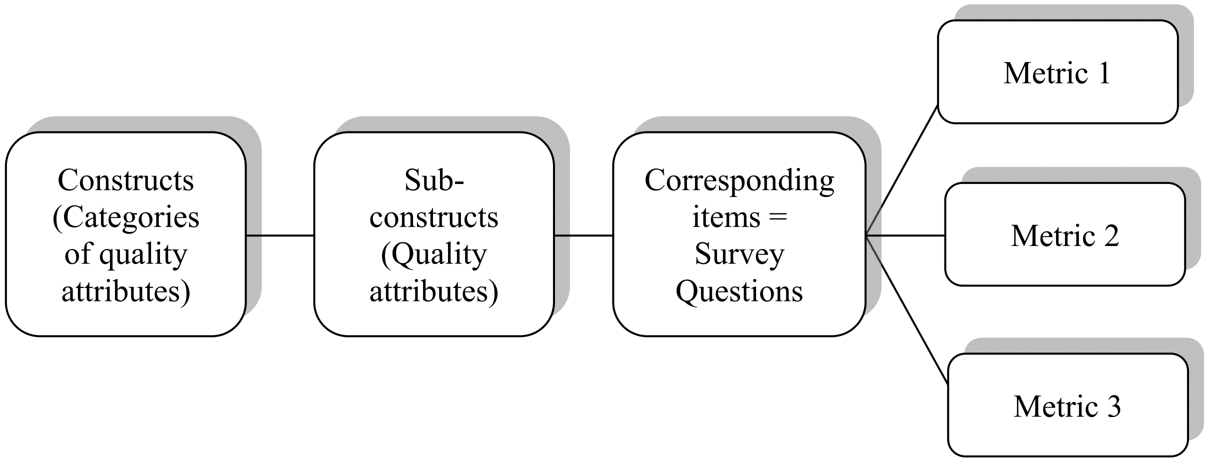


Figure 2.2 Relationship between the key terms used in construct operationalisation

The operationalisation process in this study was completed via the Systematic Literature Review by identifying constructs (quality attributes sorted into content quality, platform quality and user satisfaction categories) and sub-constructs (related quality attributes placed into three main categories). Initially, 58 quality attributes were identified through the literature. The most applicable quality attributes were identified by considering the frequency of occurrence of each quality attribute in the SLR search. By analysing attributes with similar meanings and the importance of these attributes in assessing the quality of knowledge management software (particularly by considering the quality attributes for effectiveness of learning though knowledge management software), the total number of distinct attributes was reduced to 41. More details of the process adopted in identifying the constructs and sub-constructs are given in Chapter 3 which discusses the Systematic Literature Review.

Defining a suitable set of metrics is one of the most important tasks in any evaluation process for the quantitative evaluation of quality levels, and to facilitate decision making (Fuggetta et al., 1998). A goal-oriented measurement strategy known as the Goal Question Metric (GQM) approach was adopted to identify a measurement strategy in this research. The next section focuses on the metric identification process using a GQM approach to quantify the quality attributes in order to evaluate the overall quality of knowledge management software.

#### 2.7.2.1 Overview of the Goal Question Metric (GQM) approach

The Goal Question Metric (GQM) approach, a goal-oriented measurement strategy, consists of deriving measures from measurement goals to ensure the consistency and completeness of measurement plans. In this study, the GQM approach was adopted to identify metrics for each quality attribute. The GQM approach is an approach to software metrics that was promoted by Victor Basili (Basili, 1992); it was originally defined for evaluating defects in projects at the NASA Goddard Space Flight Center and the application involved a set of case study experiments. Although the approach was originally used to define and evaluate goals for a particular project in a particular environment, its use has since been expanded to a wider context (Basili, 1992).

The GQM approach is based upon the assumption that in order to measure in a purposeful way, the goals of the project should first be specified. These goals should then be traced to the data that are intended to define them operationally, and finally a framework provided for interpreting the data with respect to the stated goals (Basili, 1992). The quantified information collected using the GQM approach can be analysed to determine whether or not the goals were achieved (Khamis et al., 2008).

The application of GQM represents a measurement model on three levels in this research:

*Conceptual level (goal)*

A goal is defined for each quality attribute.

*Operational level (question)*

A set of questions is used to define each quality attribute; the answers to these questions can then be used to determine whether or not the specified goals were met.

*Quantitative level (metric)*

A set of metrics is defined based on the quality attributes associated with every question in order to answer it in a measurable way.

By using the GQM approach, many current approaches to measurement are combined and generalised including processes and resources as well as product assessments. This approach is therefore sufficiently flexible to be used in different environments; it has been applied in numerous organisations such as NASA, Hewlett Packard, Motorola, and Coopers & Lybrand (Basili, 1992).

Figure 2.3, below, depicts the application of the Goal Question Metric approach in the present study. A GQM model is a hierarchical structure (see Figure 2.3), starting with a goal (specifying the purpose of measurement, the object(s) to be measured, the issue(s) to be measured and the viewpoint from which the measures are taken). The goal is then refined into several questions that break down the issue into its major components, and each question is refined into metrics; some of them are objective and some are subjective. In this study, subjective measures were obtained for each goal (by using the questionnaire survey). The same metric can be used to answer different questions falling within the same goal. Several GQM models can also have questions and metrics in common, ensuring that when the measure is actually taken, the different viewpoints are taken into account correctly, as the metric might have different values when measured from different viewpoints (same question can be used to measure different quality goals) (Basili, 1992). After the measures have been specified, data collection mechanisms, including validation and analysis mechanisms, must be developed. A brief description of each sub-construct to be evaluated and the questions formulated to evaluate each sub-construct are given sorted into three main constructs (see Appendix 2.3).

### 2.7.2.2 Identifying goals

The starting point to the GQM approach is to identify quality goals. This stage is one of the most critical stages in ensuring the successful application of the GQM approach. At the end of it, a set of goals associated with each quality attribute will have been identified. In this study, the constructs and sub-constructs identified in the SLR (further explained in Chapter 3) were used in defining the goals, questions and metrics. For each quality attribute, a brief description was set based on the origin of the quality attribute and the features of KMS platforms, as described in Chapter 5.

Goals were defined by specifying the purpose of the measurement, the object to be measured, the issue to be measured, and the viewpoint from which the measure was to be taken. An example of goal setting for the "easy to use" attribute can be represented as follows: for the purpose of quality measurement (purpose), the ease of use (object) was to be evaluated with respect to KMS platform quality (the issue to be measured), from the users' viewpoint (viewpoint), in a given KMS platform (environment). See Figure 2.4 for an example of the application of the GQM approach in this research. Appendix 2.3 explains how the goal of each quality attribute in the quality assessment framework was identified.

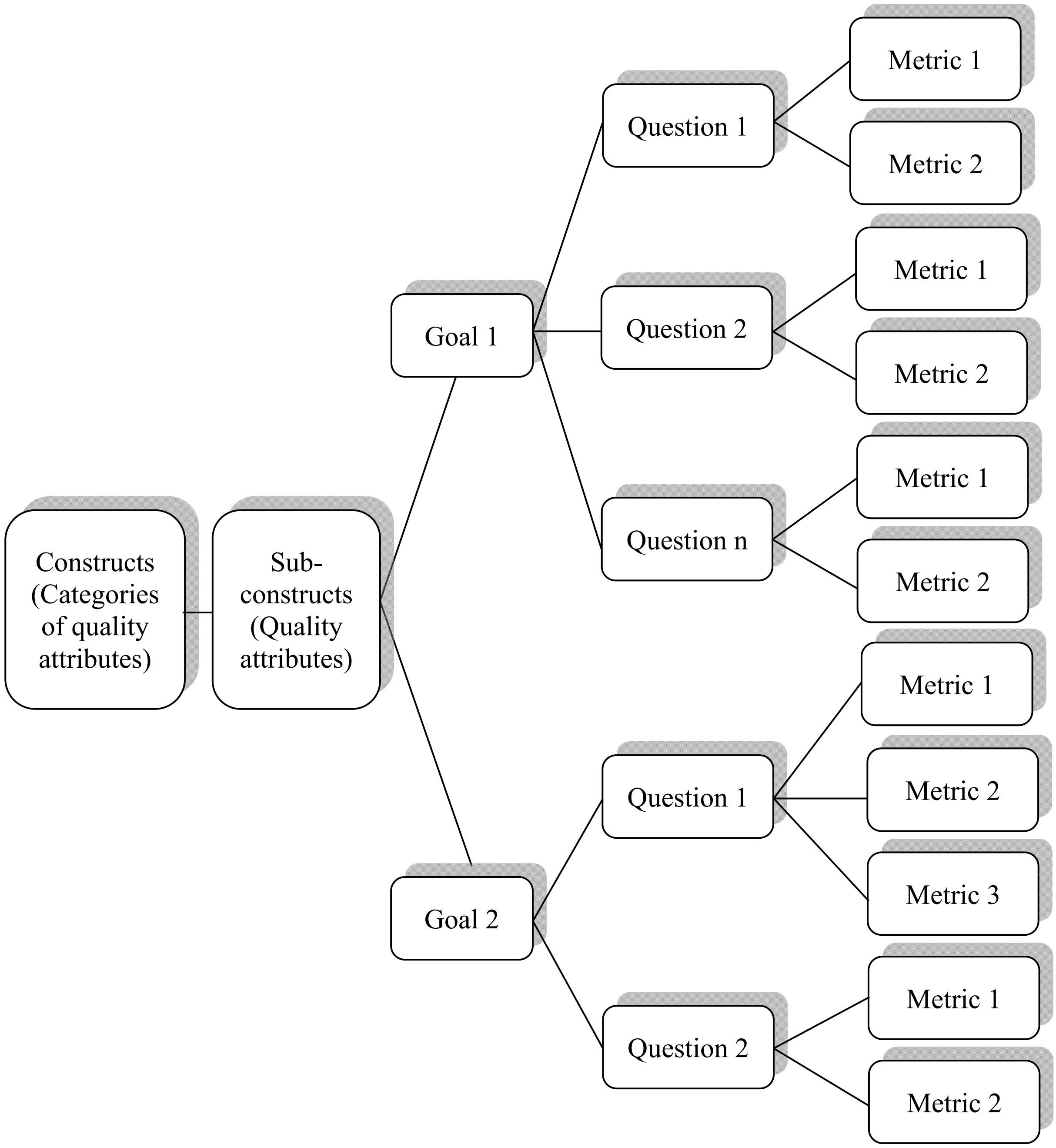


Figure 2.3 Application of the GQM approach

### 2.7.2.3 Derivation of questions

The identified goals were then used to formulate relevant questions to provide clearer definitions of the goals, and to identify quality metrics in order to measure quality in a quantifiable way. Based on the goals identified in the previous stage, and based upon the quality attributes of knowledge management software, questions were derived that defined those goals as completely as possible, and in a manner that would allow the answers to provide measurable values. For example, the goal mentioned previously was measured using questions B1: KMSS is easy to use, B2: I can find the required information easily, B5: The help provided in the system is easily accessible and useful, and B6: The graphical user interface of the KMSS is user friendly. Figure 2.4 illustrates an example of how questions were derived for a goal.

This stage describes how the sub-constructs (quality attributes) were converted into survey questions in the questionnaire. Once the sub-constructs for each construct were identified, the next step was to derive survey questions or items for the selected pool of sub-constructs. Survey items can be fixed-choice (where the respondents select his/her response from a set of options), or open-ended (where the respondents are asked to enter their own responses to a given question). The questions derived for each quality attribute in this manner are presented in Appendix 2.3.

The number of items used to measure a sub-construct should adequately sample the domain of interest, while remaining as parsimonious as possible (Cronbach and Meehl, 1955), because surveys with too many items can induce a response pattern bias, while those with too few may jeopardise the content and construct validity (Nunnally et al., 1967). There may be one or more items for each sub-construct.

The publications in the SLR were reviewed in search of the best potential questions for each sub-construct. The best-suited multiple items were derived to evaluate each sub-construct.

The overall results after identifying each construct and sub-construct were presented to a group of experts in software engineering and instrument design. Their feedback was also incorporated into the process of deriving questions for each of the sub-constructs.

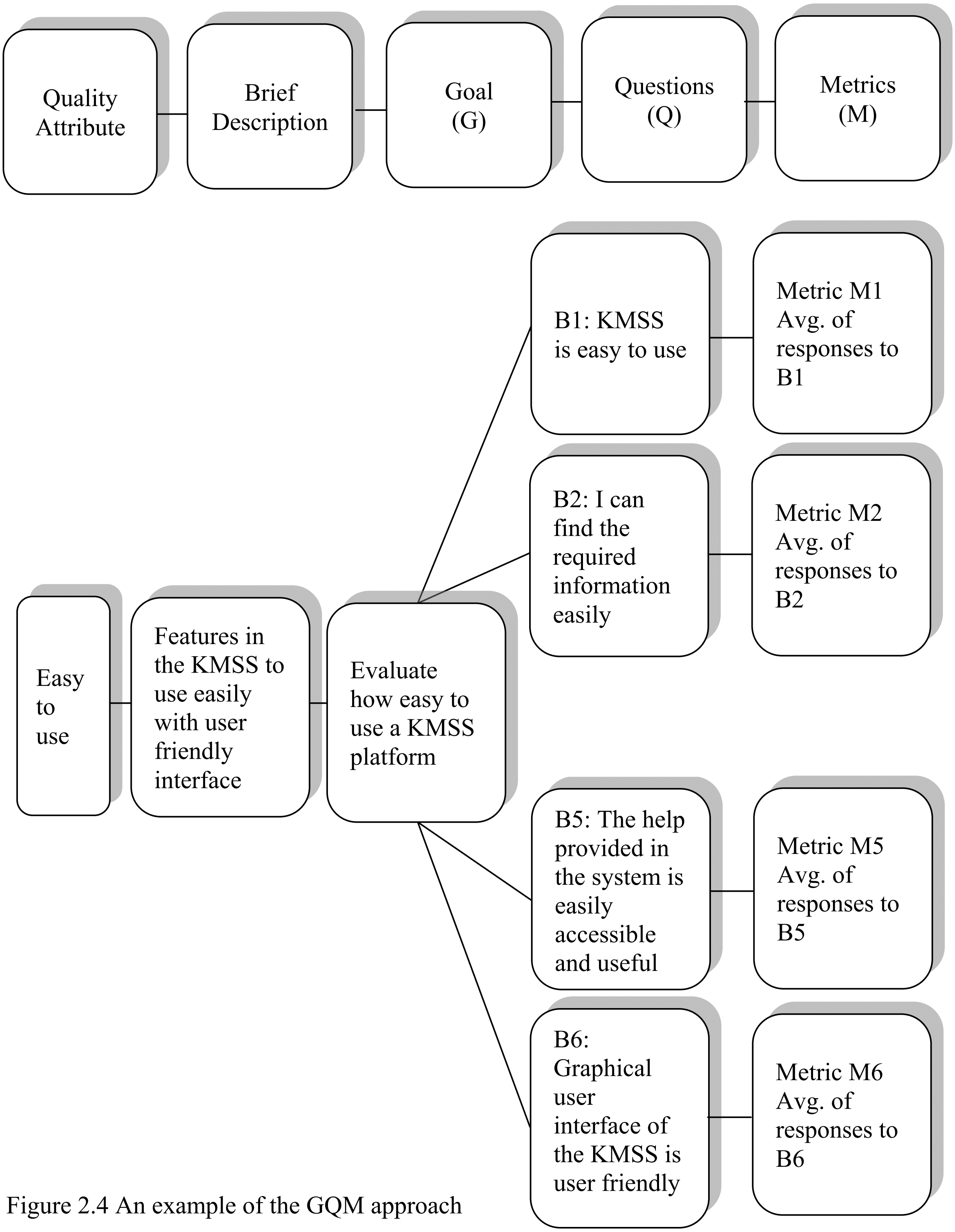


Figure 2.4 An example of the GQM approach

### 2.7.2.4 Identifying metrics

The next step in the GQM approach involves specifying the measures required to answer those questions. In other words, these measurable metrics are used to quantify the responses to questions. The values derived from these metrics were used in this study to calculate the quality score for each quality attribute for the three categories of quality attributes, and also for overall quality (as described in more detail in Section 6.4 in Chapter 6). For this purpose, the responses obtained from the questionnaire survey were quantified using descriptive statistical measures. The averages of responses to the questions relating to each quality attribute were combined to calculate a single value metric for each quality attribute (sub-constructs). An example of the application of the Goal Question Metric approach is illustrated in Figure 2.4, above.

### 2.7.3 Survey instrument design

A questionnaire survey was designed and used to ascertain the perceptions of users regarding the quality attributes of knowledge management software by giving ratings for the quality attributes in the proposed quality assessment framework. The literature on questionnaire design was reviewed before designing the instrument for the present study (Oppenheim, 2001, Creswell, 2012, Bryman, 2003). Each question in the questionnaire related to one or more quality attributes, and vice versa. A 5-point Likert-type scale was used to rate the quality attributes that would be evaluated by each question. The answer scale for the questions was a choice of 1-Strongly Agree, 2-Agree, 3-Neutral, 4-Disagree and 5-Strongly Disagree. The familiar words for users to reflect each of the attributes were identified by considering the general features of knowledge management software (described in Section 5.2.2). Questions were formulated in order to measure the quality attributes of knowledge management software in a quantifiable way, and were derived using the GQM approach to design the instrument, as Appendix 2.4 explains further. Quality attributes related to content were evaluated through the responses given to questions A1 to A14. Platform quality was evaluated through the responses to questions B1 to B12, and user satisfaction through responses to questions C1 to C8. The first version of the survey instrument was drafted after consolidating the results presented up until that time. A number of elements had to be addressed prior to deriving a complete instrument. The following sections address these elements in detail.

**2.7.3.1 Instructions**

Questionnaires should be self-explanatory, in that it should be possible for them to be filled out in private without supervision. They should consist of general instructions on the overall survey, and specific instructions (when relevant) for different sections within the instrument (Fink and Kosecoff, 1985). Care was given to ensure that this study abided by these recommendations, and that clear instructions were provided (see Appendix 2.4 for a copy of the paper-based instrument).

**2.7.3.2 Construct labelling and definitions**

It has been observed that even when "*one is not measuring theoretical ideas... you must define your terms... It is best to adopt a respected point of view... and when possible, an already existing and tested survey form"* (Fink and Kosecoff, 1985). The three main constructs included in the study, i.e. 'content quality', 'platform quality 'and 'user satisfaction,' were introduced with definitions (Appendix 2.4). These definitions were derived after reviewing definitions used in the prior literature, inviting experts to review the instrument, and pilot testing rounds of the instrument. All of the above mentioned measures were provided to ensure that the respondents understood the concept being evaluated by the survey items. Further, individual items were edited and phrased in order to suit the respondents, according to the target sample and based on the results of the pilot testing of the questionnaire.

#### 2.7.3.3 Item wording

Items belonging to the same construct were grouped together. These were always preceded by construct definitions, as described in the previous sub-section of the thesis. Some criticisms were provided in the literature regarding positively and negatively worded items in that both pros and cons of either positively or negatively wording the items were evidenced. However, in this study positively worded items were used. Each item was reviewed several times with the supervisor to avoid any occurrences of long complex questions, double negatives, jargon or abbreviations, as well as any words with double meanings, leading questions, or emotionally loaded questions.

#### 2.7.3.4 Selecting the scales

A scale refers to the choice a respondent is given to provide an answer to each item, and can be designed in multiple different ways, e.g. via categorical, comparative, differential, graphical, interval, nominal, ordinal, ration or summated scales (Fink and Kosecoff, 1985). Using the appropriate scale is an important consideration in the instrument design process, especially when it is to be used to evaluate the constructs of a quality assessment framework. Many validated scales have been proposed that can be used in research, so finding the right one(s) for a particular piece of research can be challenging. The constructs in this study were designed primarily to gather users' perceptions of the constructs via a range of sub-constructs identified by the SLR. Closed-ended Likert-style questions were designed for this purpose.

Likert-type scales have been used by researchers for decades since their original development in 1932 by Rensis Likert (Hodge and Gillespie, 2003). This type of scale consists of a series of declarative statements, where a respondent is asked whether s/he agrees or disagrees with each statement, and if so, to what extent. Likert scales are acknowledged as the most frequently used scale in the gathering of users' perceptions in general and information technology related surveys in particular, and they also fit well with the purpose of the questionnaire survey in the present study. The length of the scale (e.g. 1 to 5; 1 to 7; 1 to 10) is an important aspect to be decided by the researcher, and in this study, a five-point scale ranging from "Strongly Agree", "Agree", "Neutral", "Disagree" and "Strongly Disagree" was chosen.

#### 2.7.3.5 Designing the overall layout and order of questions

Appendix 2.4 contains a copy of the paper-based survey instrument, which clearly indicates the overall layout followed. On the first page, a brief introduction to the study and its goals and general instructions were given, before the actual questionnaire items. A smooth flow between the questions was ensured, in line with the basic guidelines followed (Fink and Kosecoff, 1985). The purpose of the questionnaire survey was to gather users' perceptions of the quality attributes of the KMSS prototype, but not the MySQL software that was also used in executing learning activities. Therefore, clear instructions were given to the respondents to consider only the quality attributes of the KMSS prototype, not the MySQL software.

Three sections of the questionnaire covered the quality attributes of knowledge management software, i.e., content quality, platform quality and user satisfaction. Questions were sorted into section A - Content quality, Section B - Platform quality and Section C - User satisfaction. At the end of sections A, B and C which had closed ended questions, three open-ended questions were then set to obtain users' perceptions of the positive and negative features of the KMSS prototype.

#### 2.7.3.6 Instrument distribution modes

In this study, a web-based instrument similar to the instrument outlined in Appendix 2.4 was used in the KMSS prototype developed in this research. There have been various debates on the pros and cons of using electronic surveys in the literature; however, most recent studies have used them due to their low cost, ease of administering, fast distribution, and the enabling of the analysis of results using stored responses, each of which are advantages over paper-based instruments (e.g. in terms of their cost of printing and distributing by mail with prepaid envelopes). In the context of this study, the advantages of web-based instruments outweighed the limitations. The target population of this study was undergraduate and postgraduate students who are computer literate and familiar with using web-based forms in virtual learning environments. Therefore, a web-based instrument simplified the data collection.

### 2.7.4 Sample selection

Questionnaire surveys are often referred to as sample surveys because the information that the researcher wishes to gather is usually collected from a pre-selected group of people, known as a sample (Henn et al., 2006). In empirical data collection, identifying the unit of analysis, population, sample and method of sampling is an important activity. This section gives the key details about the sample selection process in this research.

The unit of analysis in this questionnaire survey were the regular users of knowledge management software and novices to learning in the subject field of database management. The population considered for the data collection were students in the School of Computing and Mathematics at Keele University, UK. In general, data collection is performed using random and non-random samples. In this research, a non-random sampling method known as convenience sampling is used, in which the researcher selects participants because they are willing and available to be studied (Creswell, 2012). In this study, an e-mail notification was sent to the students on undergraduate and postgraduate degree programmes in the School of Computing and Mathematics at Keele University (a copy of the invitation e-mail for data collection is given in Appendix 2.5). Students who wished to volunteer for the data collection were invited to participate in the questionnaire survey. A sample of 28 students on undergraduate and postgraduate programmes was selected for the questionnaire survey. Although most studies in software engineering have to use convenience sampling, this sampling method is known to result in various types of bias, such as self-selection bias (i.e. those most interested in this research may have different characteristics from the population as a whole) (Lethbridge et al., 2005). The results must always therefore be reported with an acknowledgement of potential biases and other threats to validity, and they should be used with those possible biases in mind. In most cases, slightly biased data is still much more useful than a complete lack of data (Lethbridge et al., 2005). In order to minimise the bias, a sample was selected by considering similar academic backgrounds (e.g. those who are regular users of knowledge management software, and novices to learning in the subject field of database management), and by considering the purpose of the sample selection in the research. As another measure to minimise the bias, a similar sample of 30 participants were selected from the School of Computing, University of Colombo, Sri Lanka. The same procedure used for the sample selection and data collection at the School of Computing and

Mathematics, Keele University, UK was also followed at the School of Computing, University of Colombo, Sri Lanka.

### 2.7.5 Pilot testing of questionnaire

The pilot testing of the questionnaire as well as the process of carrying out the questionnaire survey was followed by the pilot testing of the KMSS prototype, which is further described in Section 5.4.1 below. The questionnaire was pilot tested by inviting 5 participants to carry out the same tasks as those set for the planned data collection. Those participants were students of the School of Computing and Mathematics at Keele University., and were excluded from the final sample. The participants were told the purpose of their participation and a request for their participation was sent via e-mail. A feedback gathering sheet was given to the participants to collect feedback on the overall process of data collection, the layout of the questions in the questionnaire and the overall timing to complete the questionnaire. This data was systematically gathered, consolidated and integrated to build an improved version of the questionnaire.

### 2.7.6 Conducting the questionnaire survey

The purpose of questionnaire survey in this research is to collect data on quality attributes of the KMSS prototype. Participants were given activities to be completed using the KMSS prototype before responding to the questionnaire survey. Details of the process involved in conducting the questionnaire survey and the results of doing so are described in Section 5.4.

### 2.7.7 Data cleansing

The responses to the questionnaire were collated, cleaned and codified before analysis. Researcher memos were maintained throughout this process, because notes taken at this stage could be used in future replication studies which also utilise this instrument. Any missing values were identified and a data cleaning rule was applied to the answers to three open ended questions. The final set of data was then entered into a spreadsheet for statistical analysis. The collected and cleansed data set was used in the data analysis presented below in Section 5.4.

### 2.7.8 Data analysis

The data analysis method for this research was selected by careful consideration of the type of data requiring analysis and the conclusions that could be made in order to satisfy the research objectives. There are two main approaches to analysing experimental results (Kitchenham et al., 2002), which are as follows:

- Classical analysis (often referred to as the "frequentist" approach), which is adopted by most statistical packages.
- Bayesian analysis, which provides a systematic means of making use of "prior information". Prior information may be obtained from previous studies of the phenomenon of interest, or from expert opinion.

In this research, classical analysis (frequency analysis) was used for the treatment of descriptive information. One way to organise raw data is to group scores or values into frequencies (Black, 1999). The frequency of occurrences and percentages of each data variable can then be reported using frequency tables; these frequencies are helpful in comparing and contrasting within or across groups of variables. Frequencies for both nominal/ordinal as well as numeric data were considered in the data analysis. In the present study, frequency analysis was used to analyse the data collected through the SLR and the questionnaire survey. The method of application of the frequency analysis in this research is described below.

Firstly, the frequency of occurrence of each quality attribute in the publications selected in the SLR was calculated. By comparing the number of occurrences of each quality attribute in articles with the total number of articles in the SLR, the percentage of the frequency of occurrence of each quality attribute was computed. For example, 12 articles in total which mentioned the quality attributes of knowledge management software were considered in the SLR. If a quality attribute is reported in 6 of those articles, then the frequency of occurrence is 50% for comparative purposes. Based on the frequency of occurrence, a rank of occurrence for each quality attribute could be computed.

Secondly, through the questionnaire survey, the frequency of responses to questions in the "strongly agree" and "agree" categories were calculated. If more than one question fell under a quality attribute, the average of number of questions under the quality attribute was computed. For example, 3 questions assessed the quality attribute "easy to use". The average of the responses to these three relevant questions in the questionnaire was considered to compute the frequency for the "easy to use" quality attribute. Using this frequency, the relative importance of each quality attribute could be calculated.

The responses to open ended questions were analysed by considering the participants' responses to these questions. Quotes have been used to illustrate some examples in the data analysis. In addition to frequency tables, graphical representation methods such as bar charts, pie charts and figures have also been used. The data analysis was conducted using SPSS statistical software, and the results are presented in Chapter 6.

### 2.8 Data collection through evaluating academic performance

Learning effectiveness is one of the parameters that imply the quality of the learning environment. In this study, a higher score for assessment tasks was considered an indication of accomplishing the learning outcomes to a level that reflects effective learning through the knowledge management software. For this purpose, the learners were given assessment tasks (a quiz and a practical test) to carry out after learning the tutorial on introduction to database management given in the KMSS prototype. The overall score and the grade for these assessment tasks were considered to represent an evaluation of the effectiveness of learning. The process of data collection using this method and the results are presented in Section 5.4.

### 2.9 Application and evaluation of the quality assessment framework

A range of KMS platforms were selected for the application and evaluation of the quality assessment framework. A Quality Index formulated based on a multi-element analysis technique was used for the quantitative evaluation of the quality of each KMS platform. Data gathered from a questionnaire survey from a sample of regular users of knowledge management software and from the SLR was used to calculate the Quality Index. Details of the data collection and the results of this evaluation are described in Chapter 7.

### 2.10 Keele ethical requirements

Before conducting this research, an ethics application was approved by the Keele University Ethical Review Panel. The data collection for this research was designed to meet the university's ethical requirements, which cover the protection of subjects from harm, deception and loss of privacy. The dignity and interests of the participants were respected at all times. Informed consent was obtained from them to disseminate the results of this research in the present thesis, at conferences, and in journal articles, subject to maintaining the confidentiality of the individual participants. Prior to the beginning of the data collection, the participants were informed about the nature of the research through an information sheet provided to them. The approved ethical review application and supporting documents are included in Appendix 2.6.

### 2.11 Limitations of the research design

This research design contains some limitations associated with the data collection through the SLR and the questionnaire survey.

A major limitation in carrying out an SLR is the lack of control in using electronic databases to collect a large amount of publications. As the results from these databases will be returned automatically for selected search strings, little influence can be exerted over what they return, leading to search results which are not identical to one another when identical queries are run. Several measures were taken to minimise these limitations, including pilot testing of the protocol and the sampling of results by reviewers (two PhD supervisors) independent of the main researcher (the author). However, it was not possible for the secondary reviewers to check each and every paper returned by the searches. More details of the limitations involved in the execution of the SLR are described in Section 3.4.

Further, a key disadvantage of the questionnaire survey method is that respondents are provided with a list of questions on the quality attributes identified through the SLR. This can lead to pre-empting of the quality attributes considered and to limiting them to those reported by the existing studies, as respondents may only focus on the quality attributes provided in the questionnaire. Three open ended questions were set in the questionnaire to address this issue. In order to ensure the rigour and reliability of the data collection, several measures were taken as described in the data collection protocol (Section 5 in Appendix 2.1). The application of these measures to ensure the rigour and reliability of the data collection is described in Section 5.5 in Chapter 5.

### 2.12 Summary

In this chapter, the most commonly used research methods in software engineering which are originated from social sciences (quantitative, qualitative and mixed method) were reviewed in order to select the most suitable research methodology for this study. Different research methods were discussed along with an explanation of the reasoning behind the choices made for this work, specifically with regard to the SLR and the questionnaire surveys. A protocol for data collection was developed and used as a roadmap for the data collection described below in Chapter 5. Each step in the data collection taken using these methods was described in this chapter. Finally, the limitations in the research design and the measures taken to ensure the rigour and reliability of data collection were discussed. Keele University's Ethical review procedure was followed, and this process was described. The execution of the data collection through the SLR is now described in Chapter 3 and the questionnaire survey is described later, in Chapter 5. The formalisation of the quality assessment framework using the data collected through the SLR and the questionnaire survey is described in Chapter 6.

The data collection relating to the application and evaluation of the quality assessment framework is then described in Chapter 7.

# Chapter 3: Systematic Literature Review

### 3.1 Chapter synopsis and outline

A Systematic Literature Review is a methodical way of collecting evidence on a topic. It is a trustworthy, rigorous and auditable approach that involves following a set of predefined steps in collecting, analysing and reporting the existing evidence on a topic. As described in Chapter 2, a Systematic Literature Review is one of this research's main sources of data, underpinning the formalisation of a quality assessment framework for knowledge management software in this research. The process of the SLR, the results at each step in executing the SLR, and some reflections on conducting SLR are set out in this chapter, which is organised as follows:

- The process of the Systematic Literature Review is described in Section 3.2
- In Section 3.3, the results of the Systematic Literature Review are described.
- The limitations of this SLR are described in Section 3.4.
- The reflections identified through the SLR are discussed in Section 3.5.
- A summary of the chapter is given in Section 3.6.

### 3.2 Process of the Systematic Literature Review

Before the beginning of the SLR process, in order to gain an overview of the related work on KMS, a broad search of the existing literature was undertaken. The abstracts and full papers of the most relevant publications relating to the quality assessment of KMS were reviewed. The relevant references were stored using EndNote reference management software. This preliminary search enabled the identification of relevant journals and conferences, provided an overview of the most investigated topics, confirmed the most relevant publications for the SLR, and identified the gaps in the existing research. Although this primary stage does not form part of the SLR process, it provided valuable knowledge which contributed to designing the process. It also provided further motivation to conduct a comprehensive SLR in this research.

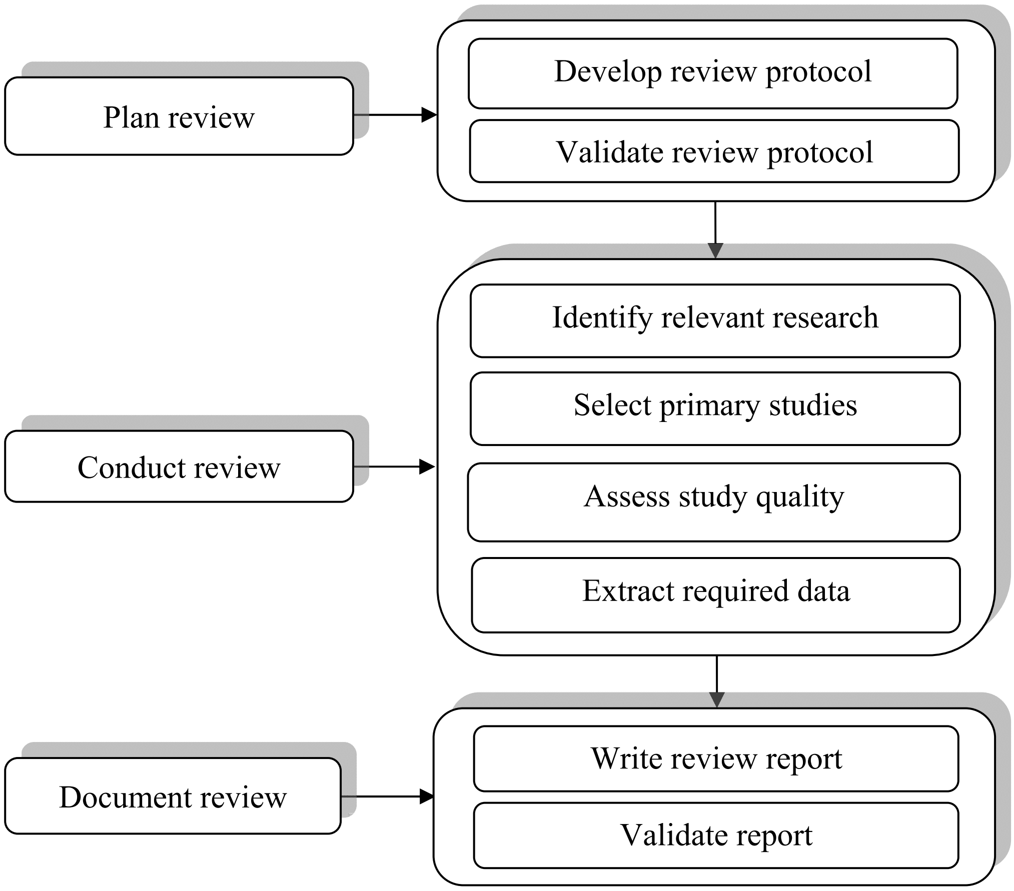


Figure 3.1 Systematic Literature Review process

Guidelines proposed by a prior study (Kitchenham and Charters, 2007b) formed the basis for the process adopted in conducting this research's SLR. The SLR process has three main phases: planning, conducting and documenting the review findings, as shown in Figure 3.1, above. The activities in the planning phase involve developing and validating the review protocol. In the second phase of the SLR process, the relevant research studies were identified from the sources. More details on identifying the relevant publications, selecting primary studies, the quality assessment of publications and extracting the required data are given in the next sub-sections of this thesis. In the third phase, the SLR report had to be documented and validated. The following sections also trace the execution of the above-mentioned phases and the results at each stage.

### 3.2.1 The SLR protocol

The SLR protocol for this research specifies the research questions, search strategy, inclusion/exclusion and quality criteria, data extraction and methods of synthesis. An initial SLR protocol was developed as the first step and used as a roadmap for the next stages of the SLR, having been reviewed by two supervisors and an external reviewer (Prof G.T.F de Silva, a senior lecturer from Sri Lanka expertise in similar research). The recommendations made by these reviewers were implemented before the protocol was executed. Finally, it was reviewed by an expert (Prof Pearl Brereton of Keele University). The SLR protocol for this research is given in Appendix 2.2.

### 3.2.2 Research questions

The main objective of this SLR was to discover the various approaches to quality assessment in knowledge management software with a view to leveraging a quality assessment framework for knowledge management software. As a first step, the research questions were devised based on the underlying motivation for each research question, as given in Table 3.1, below.

| Research question | Main motivations |
|---|---|
| RQ1: Which topics have been investigated by researchers working on Knowledge Management Systems (KMS) or e-Learning Systems? | To identify the investigated topics in KMS or e-Learning systems with a view to categorise papers on different topics |
| RQ2: What does quality mean in relation to KMS or e-Learning Systems? | To identify what is meant by quality in the context of KMS or e-Learning systems |
| RQ3: What are the quality attributes of a KMS or e-Learning software? | To identify the quality attributes which are specifically required in KMS or e-Learning software |
| RQ4: What are the methods of assessing quality in KMS or e-Learning software? | To identify the methods for quality assessment used in KMS or e-Learning software |
| RQ5: How is learning effectiveness measured in KMS or e-Learning systems? | To identify the methods used to measure learning effectiveness in KMS or e-Learning systems |

Table 3.1 Research questions and main motivations

### 3.2.3 Search process

The first stage of the search process was devising search strings based on the keywords related to the study's research questions. Table 3.2 summarises the key words and search terms identified for each research question with a view to extract as many of the related publications as possible for this research. The inclusion of search terms related to KMS such as e-Learning, online learning and learning management systems was also likely to increase the number of publications relevant to this study.

| Research Questions | Keywords | Search Strings |
|---|---|---|
| RQ1: Which topics have been investigated by researchers working on Knowledge Management Systems (KMS) or e-Learning Systems? | knowledge management system, learning management system, knowledge management software, on line learning, e-Learning, LMS, KMS | ((((“knowledge” OR “learning”) AND “management”) OR “KM” OR “e-Learning” OR “on line learning”) AND (“system” OR “systems”) OR “LMS” OR “KMS”) |
| RQ2: What does quality mean in relation to KMS or e-Learning Systems? | quality, knowledge management system, learning management system, knowledge management software, on line learning, e-Learning, LMS, KMS | ((“quality” AND (((“knowledge” OR “learning”) AND “management”) OR “e-Learning”) AND (“system” OR “systems” OR “software”)) OR “ KMS” OR “LMS”)) |
| RQ3: What are the quality attributes of a KMS or e-Learning software? | quality attributes, quality factors, knowledge management system, learning management system, knowledge management software, on line learning, e-Learning, LMS, KMS | ((“quality” AND (“attributes” OR “factors”)) AND ((“knowledge” OR “learning”) AND “management”) OR “KM” OR “e-Learning”) AND (“system” OR “systems” OR “software”) OR “LMS” OR “KMS”) |
| RQ4: What are the methods of assessing quality in KMS or e-Learning software? | methods of assessing quality, ways of assessing quality, techniques of assessing, quality, knowledge management system, learning management system, Knowledge management software, on line learning, e-Learning, LMS, KMS | (“method” OR “methods” OR “way” OR “ways” OR “technique” OR “techniques OR “measure” OR “measures”) AND (“assess” OR “assessing”) AND “quality” AND (((“knowledge” OR “learning”) AND “management”) OR “KM” OR e-Learning) AND (“system” OR “systems” OR “software”) OR “KMS” OR “LMS”) |
| RQ5: How is learning effectiveness measured in KMS or e-Learning systems? | quality assessment, evaluating learning effectiveness, quality evaluation | (“on line learning” OR “e-Learning” OR “learning management system” OR “learning management systems” OR “knowledge management system” OR “knowledge management systems” OR “KMS” OR “LMS”) AND (“quality” OR “learning effectiveness” OR “assessment” OR “evaluation”) |

Table 3.2 Keywords and search terms for Research Questions (RQs)

The search process comprised manual and automatic searches of electronic databases. This strategy was identified as the most suitable method by which to gather the most relevant publications after performing trial searches while devising the SLR protocol. The electronic databases searched during this SLR included ScienceDirect (http://www.sciencedirect.com/), EBSCOhost (http://www.EBSCOhost.com/), ISI Web of Knowledge (http://apps.isiknowledge.com), ACM (http://www.acm.org/), and SpringerLink (http://www.springerlink.com/). Each electronic database has its own set of search criteria and method of exporting the results to reference management software, so the procedure used in each case to extract the related publications from each electronic database was different. Details of the search terms used for each electronic database and a sample of results retrieved is given in Appendix 3.1.

The search strings used for the electronic databases were tested using trial searches. Search strings were considered to have been validated when 3 publications (Lau and Tsui, 2009), (Rao and Osei-Bryson, 2007), and (Wang, 2007) identified as important during the proposal development were returned in the trial search. The reference mentioned in the articles accepted into the SLR were also analysed in an attempt to find any additional literature of interest that had not been discovered during the automatic and other manual searches. The inclusion and exclusion criteria described in the SLR protocol (Appendix 2.2) were used to ensure that only relevant publications were accepted into the SLR.

### 3.2.4 Selection criteria

The selection criteria in this study's SLR specified the criteria for the inclusion and exclusion of publications on the selected list of publications. The criteria explained below were identified in order to extract all the relevant literature and to eliminate the possibility of inclusion of publications which are not relevant to the SLR.

**Inclusion criteria**

The following criteria were used to determine the inclusion of publications retrieved in the data extraction using search strings.

- The date of publication did not act as a barrier to inclusion.
- Where several papers reported the same study, only the most recent paper was included.
- Relevant technical papers were accepted if publicly accessible.
- Publications on the quality assessment of KMS as well as e-Learning environments were included.

**Exclusion criteria**

The following criteria were used to determine the exclusion of publications retrieved in the data extraction using search strings.

- Publications were excluded if their main focus was not related to the research questions.
- Other articles, such as unpublished reports, letters and editorials, prefaces, article summaries, interviews, news, reviews, correspondence, discussions, comments, readers' letters and summaries of tutorials, workshops, panels and poster sessions were excluded.
- Papers written in languages other than English were excluded.

### 3.2.5 Publication selection

The publication selection process was carried out in two phases: initially using the title, abstract, and keywords, and secondly using a full text review. The publications found during the initial search were assessed for their suitability based upon an analysis of their title and abstract. Clearly irrelevant publications were excluded according to the exclusion criteria.

Figure 3.2 shows the stages of the primary selection of publications used in this SLR. The publications identified at each stage were checked for their validity based on the inclusion criteria. In the first stage, the titles, abstracts and keywords of the articles in the electronic databases were searched using the search strings mentioned in Table 3.2. At the second stage, some publications were excluded based on their titles. The final list of publications was selected after reading the abstracts at the third stage. Finally, the entire paper was reviewed to assess its quality and to extract the relevant evidence for the present study's research questions. The results of each of this search process are presented in Section 3.3, below.

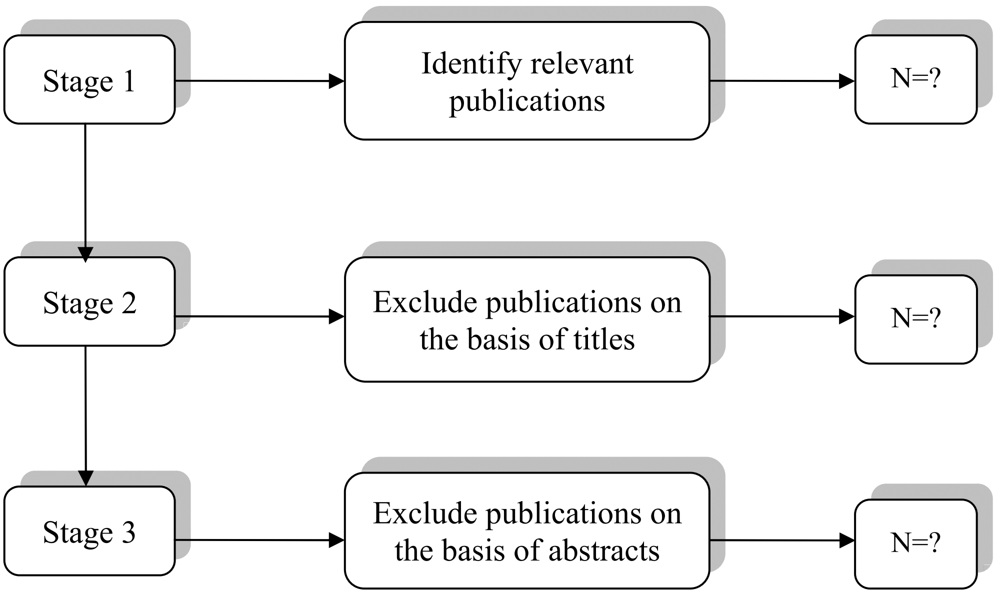


Figure 3.2 Stages of the primary selection of publications

In order to reduce possible researcher bias, an inter-rater reliability test was performed. The secondary reviewer (a research supervisor) randomly selected five publications from the list of the initially selected publications, and performed the above described selection processes. Their results were compared with those produced by the primary reviewer (the author), and no disagreements were found.

### 3.2.6 Quality assessment of publications

This section explains the quality assessment procedure employed in this research to ensure that the selected set of publications would provide valuable contributions in the SLR. The quality assessment of each publication selected for the final set was carried out at the time of extraction. The quality assessment criteria used in a previous study (Dybå and Dingsøyr, 2008) was also chosen for this SLR since they comprehensively explained the quality assessment of different types of research articles extracted which is suitable for quality assessment of the types of articles to be reviewed for this SLR. The 11 criteria covered the three main issues pertaining to quality mentioned below that needed to be considered when appraising the studies identified in the review. These were as follows:

Rigour: Has a thorough and appropriate approach been applied to the key research methods in the study?

Credibility: Are the findings well-presented and meaningful?

Relevance: How useful are the findings to the software industry and the research community?

Taken together, these 11 criteria provided a measure of the extent to which the researcher could be confident that a particular study's findings could make a valuable contribution to the review. In summary, the 11 criteria used to assess the quality of each publication were:

1. Is the paper based on research or is it a “lessons learned” report based on expert opinion?

2. Is there a clear statement of the aims of the research?

3. Is there an adequate description of the context in which the research was carried out?

4. Was the research design appropriate to address the aims of the research?

5. Was the recruitment strategy appropriate to the aims of the research?

6. Was there a control group with which to compare treatments?

7. Was the data collected in a way that addressed the research issue?

8. Was the data analysis sufficiently rigorous?

9. Has the relationship between researcher and participants been considered to an adequate degree?

10. Is there a clear statement of findings?

11. Is the study of value for research or practice?

The first two of the criteria listed here were used to assess the minimum quality criteria, i.e. to exclude non research papers and those that did not clearly state their aims. The remaining nine criteria were used to determine the rigour and credibility of the research methods employed in the papers, as well as the relevance of each paper for inclusion in the SLR. The answer to each question relating to each item of literature included in the SLR was tabulated using the value range: 1 (Yes), 0.5 (Maybe), or 0 (No). The most relevant papers were judged and their validity was then tested by a second (research supervisor) and third reviewer (second research supervisor) in addition to the main researcher. A random sample of eight papers was given to these two additional assessors, who were asked to assess the quality of the selected papers based on the same quality assessment criteria outlined above. The result of this was that the quality assessment undertaken was considered to be valid, as the same scores were awarded by both assessors for this random sample of papers. The results of the quality assessment of the selected publications are presented in Section 3.3.2.

### 3.2.7 Data extraction

In order to answer the research questions discussed in Section 3.2.2, the following data was extracted from each publication included in the SLR:

- Abstract and study identifier (unique ID for the study)
- Date of data extraction
- Bibliographic reference (author(s), year, title, source)
- Type of article (e.g. journal article, conference paper, workshop paper, book section)
- Study's aims and objectives
- Study design (experiment, survey, case study, action research)
- Research hypothesis, if any
- Sample description
- Setting of study (industry, in-house/supplier, products and processes used)
- Methods of data collection and analysis
- Relevance of the study (e.g. in relation to the topic under consideration)
- Findings and conclusions
- Study quality assessment

The data extraction was undertaken by the present researcher, before the validity was checked by the second reviewer (research supervisor) by selecting a random sample of eight papers from the total of 81 papers. Any anomalies in the results obtained by the different reviewers were resolved after comparison with the original dataset collected with the assessment of the third reviewer (second research supervisor), so that inter-reviewer consistency could be assessed. Since no significant anomalies were identified via this validation activity, the data extraction strategy was deemed to be appropriate. All the extracted data were stored in a spreadsheet with unique identifier related to each research question.

### 3.2.8 Data synthesis

At the end of the data extraction phase, the information extracted from the selected studies was entered into a spreadsheet for data management and analysis. Then, the data were analysed to answer the research questions. The data synthesis process was validated before its application by a second reviewer (PhD supervisor). The results of the data extraction and synthesis are presented under the answers to each of the research questions in Section 3.3.3.

## 3.3 Results of the Systematic Literature Review

This section presents the results of the SLR. The results presented here are based on the execution of the SLR using the SLR process described in Section 3.2.

### 3.3.1 Search results

This section presents the results of the publication search organised according to each research question and the number of publications selected for further analysis. The search results were obtained by executing the search process described in Section 3.2. The search strings presented in Table 3.2 under each research question were used for publication searches in selected electronic databases, resulting in the retrieval of a large number of potentially relevant publications. Publications from all the years covered by the chosen databases using automatic searches were extracted. Initial searches which were carried out based on title, abstract and key words returned the results presented in Table 3.3.

| RQ | SD | EB | ACM | ISI | SL | Total |
|---|---|---|---|---|---|---|
| RQ1 | 16379 | 9452 | 1667 | 984 | 70 | 28552 |
| RQ2 | 918 | 3189 | 11 | 22 | 9 | 4149 |
| RQ3 | 163 | 4432 | 14 | 1 | 3 | 4613 |
| RQ4 | 61 | 180 | 72 | 21 | 1 | 335 |
| RQ5 | 3856 | 155 | 89 | 186 | 1 | 4287 |
| Total | 21377 | 17408 | 1853 | 1214 | 84 | 41936 |

Acronyms: SD: ScienceDirect, EB: EBSCOhost, ACM: Association of Computing Machine, ISI: ISI Web of Science, SL: SpringerLink

Table 3.3 Publications retrieved from electronic databases

A total of 41936 publications were retrieved from five electronic databases: ScienceDirect (21377), EBSCOhost (17408), ACM (1853), ISI Web of Knowledge (1214) and SpringerLink (84). Based on the number of publications retrieved, it is evident that the highest number of publications was retrieved for RQ1, while the lowest number of publications was retrieved for RQ4. These search results, which were returned automatically, were then refined using the refining criteria in each electronic database. The large amount of publications retrieved was refined by additionally considering the language of publication, the publication type, and the relevance of the subject areas to this research. Summarised information on the publications retrieved after the refining process is given in Table 3.4. The number of publications retrieved from the five electronic databases (781) using this process for each RQ consisted of: RQ1 (421), RQ2 (99), RQ3 (42), RQ4 (54), RQ5 (165). The following publications were returned from digital libraries: ScienceDirect (93), EBSCOhost (204), ACM (125), ISI Web of Knowledge (286) and SpringerLink (73).

| RQ | SD | EB | ACM | ISI | SL | Total |
|---|---|---|---|---|---|---|
| RQ1 | 35 | 31 | 37 | 250 | 68 | 421 |
| RQ2 | 23 | 54 | 11 | 11 | 16 | 99 |
| RQ3 | 1 | 34 | 3 | 1 | 3 | 42 |
| RQ4 | 0 | 21 | 26 | 6 | 1 | 54 |
| RQ5 | 34 | 64 | 48 | 18 | 1 | 165 |
| Total | 93 | 204 | 125 | 286 | 73 | 781 |

Acronyms: SD: ScienceDirect, EB: EBSCOhost, ACM: Association of Computing Machine, ISI: ISI Web of Science, SL: SpringerLink

Table 3.4 Selected publications for further analysis

### 3.3.2 Quality assessment of publications selected for SLR

This section details the quality assessment of the publications using the strategy described in Section 3.2.6. The collection of publications retrieved in the previous stages was further refined in order to extract those which met the inclusion, exclusion and quality criteria after removing duplicates. The publications retrieved after these stages (as shown in Table 3.5) were then forwarded for quality assessment. The number of publications under each research question was: RQ2 (25), RQ3 (11), RQ4 (20) and RQ5 (45).

| Electronic Database | RQ2 | RQ3 | RQ4 | RQ5 | Total |
|---|---|---|---|---|---|
| SD | 7 | 3 | 4 | 13 | 27 |
| EB | 9 | 4 | 4 | 10 | 27 |
| ACM | 4 | 3 | 7 | 4 | 18 |
| ISI | 5 | 1 | 5 | 14 | 25 |
| SL | 0 | 0 | 0 | 4 | 4 |
| Total | 25 | 11 | 20 | 45 | |

Acronyms: SD: ScienceDirect, EB: EBSCOhost, ACM: Association of Computing Machine, ISI: ISI Web of Science, SL: SpringerLink

Table 3.5 Publications included for quality assessment

Each publication in the final set was assessed for its quality. The extraction of the relevant data was followed by the quality assessment procedure with the aim of ensuring that the findings of particular publications would make a valuable contribution to the SLR. As explained in section 3.2.6, the eleven criteria for quality assessment used in a prior study (Dybå and Dingsøyr, 2008) were also followed here. The first two of these excluded non-research papers, and those papers that did not clearly state the aims of their research. As such, these two criteria represented the minimum quality requirements in this review. The remaining nine criteria aimed to determine the rigour and credibility of the research methods employed as well as the relevance of each publication to the present SLR. The answers to each question for each publication included in the SLR were inserted into a spreadsheet and assigned a value of 1 (‘Yes’), 0 (‘No’), or 0.5 (‘Maybe’). These values were then added up so that each publication included in the SLR was assigned a particular score. The number of publications under each quality criteria is presented in Figure 3.3 and the full results of the quality assessment of publications are given in Appendix 3.2.

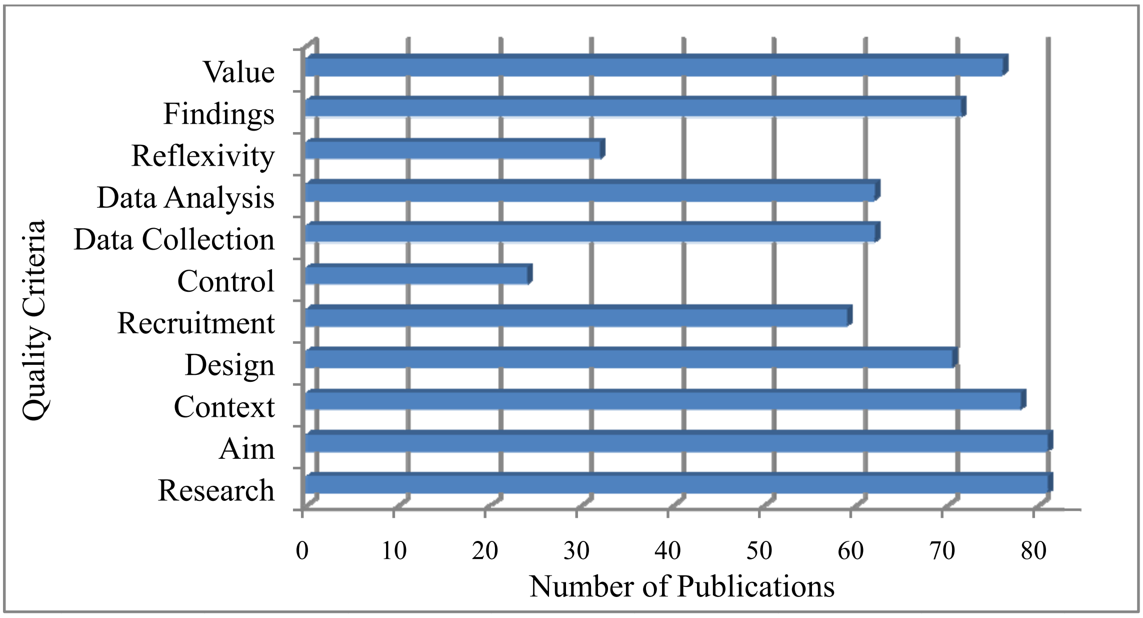


Figure.3.3 Number of publications under each quality criteria

In all, 81 publications were included in this quality assessment. Those publications for which full papers were not included in the electronic database were obtained by contacting the authors using the contact details given in the short versions of the publication in the electronic database. All these publications were fully read to identify the answers to the quality assessment questionnaire. The reference lists of these articles were also accessed in order to try to locate further related publications, but this path did not add any more publications to the collected list of publications since those articles identified as relevant from reference lists had already been included. This suggests that the search process used was sufficiently thorough and was successful in identifying all the relevant literature.

All the articles included in the review built on the prior research or presented "lessons learned," and they all clearly stated their aims. Of the 81 selected publications, 78 offered some description of the context in which the research was carried out, while 71 were considered to have an appropriate research design. An analysis of these quality assessment results also revealed how many of the publications included had no adequate recruitment strategy, failed to use a control group, did not collect (or sufficiently analyse) their data in a way that addressed the research issue, or did not consider the relationship between the participants and the researcher. The majority of studies that scored 0 in respect to any of these criteria were publications that offered "lessons learned," and which did not report any empirical data. Eleven of the studies included in the review were awarded the maximum score of 11, while the lowest score awarded was three, and the average quality score was 8.6. The median score of the publications included in the SLR was 11 (with 11 studies awarded this score). In order to test the validity of the quality assessment procedure, a second reviewer (PhD supervisor) was given a random sample of 10 papers and asked to assess their quality based on the same quality assessment criteria; no disagreement on the overall quality assessment of the papers emerged. Overall, the number of publications which passed the minimum quality threshold was 76; three publications were not included in the SLR even though they met the minimum quality criteria because they were papers which repeated the same research with minor modifications to the title, and which were retrieved from different electronic databases.

### 3.3.3 Answers to research questions

**RQ1: Which topics have been investigated by researchers working on Knowledge Management Systems (KMS) or e-Learning Systems?**

Knowledge management is a large interdisciplinary field which has investigated a wide variety of topics in KM in general and with regard to e-Learning systems in particular. It was initially unclear precisely what topics had been investigated in the fields of the quality of KM and of e-Learning systems (Gunathilake and Neligwa, 2013b). In order to overcome this issue, research question one (RQ1) was devised to identify the topics which have been investigated by researchers exploring KM or e-Learning systems. Guidelines on mapping study methodologies proposed by a prior study (Kitchenham and Charters, 2007b) were adopted for this investigation, using a process consisting of three activities: (i) a search for relevant publications, (ii) a definition of classification scheme and (iii) the mapping of publications.

(i) Search for relevant publications:

A search for relevant publications was carried out using five electronic sources: ScienceDirect (SD), EBSCOhost (EB), Association of Computing Machinery (ACM), ISI Web of Knowledge (ISI) and SpringerLink (SL) using the search string mentioned under RQ1 in the Table 3.2. The inclusion and exclusion criteria explained in Section 3.2.4 were identified in order to extract all the relevant literature and to eliminate the inclusion of publications which were not acceptable for the mapping study. A list of publications included in this initial mapping study is given in Appendix 3.3.

An initial search was carried out based on title, abstract and keywords, and the number of publications found is shown in Table 3.6. By considering the subject areas in the digital libraries, the large number of publications (28552) collected was further refined down. Finally, by reading the titles, keywords and abstracts of each paper, 275 publications were selected for this initial mapping study from ScienceDirect (35), EBSCOhost (31), ACM (36), ISI (105) and SpringerLink (68). At this stage, 175 publications were selected to be categorised, a process which is explained in the next section.

| **Publications returned/included** | **SD** | **EB** | **ACM** | **ISI** | **SL** | **Total** |
|---|---|---|---|---|---|---|
| Publications returned | 16379 | 9452 | 1667 | 984 | 70 | 28552 |
| Publications included | 35 | 31 | 36 | 105 | 68 | 275 |

Acronyms: SD: ScienceDirect, EB: EBSCOhost, ACM: Association of Computing Machine, ISI: ISI Web of Science, SL: SpringerLink

Table 3.6 Publications returned and included for categorisation

(ii) Definition of classification scheme:

The publications retrieved under the search terms were further analysed in order to categorise the topics currently under investigation in the present work. The main purpose of this categorisation was to map the collected publications relating to Knowledge Management and e-Learning systems. Publications were classified into eleven different categories, which were established iteratively. The criterion, properties of each category and number of publications falling into each category are shown in Table 3.7.

| Category | Properties | Publications | Total |
|---|---|---|---|
| 1. Guidelines for design and implementation | Standards, frameworks for development, implementation stages, educational methods, fitness for purpose, application features, lessons learned, knowledge management strategies, challenges in knowledge sharing, needs analysis, frameworks for training, weaknesses and critical success factors | [1-56] | 56 (32.0%) |
| 2. Conceptual framework | KM concepts, learner retention, KM in information systems and modelling of learners | [57-62] | 6 (3.4%) |
| 3.Quality aspects | Quality assurance, quality dimensions and best practices | [63-66] | 4 (2.3%) |
| 4.Theoretical background | Users' acceptance and role of IT | [67-68] | 2 (1.1%) |
| 5.Ontology based applications | Procedures for integration, social networks, skills assessment, conceptualisation of performance and learning objects metadata | [69-77] | 9 (5.1%) |
| 6.Architectural model | Personalisation, performance analysis, learning activity systems, interdisciplinary and integrative frameworks, intelligent tutoring, collaborative learning, context aware models, generic content models, blended learning and graphical-based systems | [78-109] | 32 (18.3%) |
| 7. Evaluation | Success factors, perceptions outcomes, motivators, pedagogical strategies and usability | [110-122] | 13 (7.4%) |
| 8. Case study | Facilitating collaborative learning, application features and KM strategies | [123-134] | 12 (6.9%) |
| 9. Technology or tool | Customisation, social navigation, mobile learning, digital video, executing experimental activities, authoring, deployment and evaluation, content reusability and automated sequencing, application of mining and fuzzy techniques, usage of multi agent system and open-source systems and implications of | [135-166] | 32 (18.3%) |

| | | | |
|---|---|---|---|
| | collaborative and peer learning | | |
| 10. Literature survey | Systematic literature review, mapping studies and literature review | None | 0 (0.0%) |
| 11. Assessing learning effectiveness | Behaviour analysis, online persistence, students' perceptions, learners' satisfaction, students' motivation, students' evaluation, disseminative capacity and students' experience | [167-175] | 9 (5.1%) |
| Total | | | 175(100.0%) |

Table 3.7 Categories of publications and properties

(iii) Mapping of publications:

The publications selected for this initial mapping (see Appendix 3.3) were grouped into the 11 categories identified in stage (ii). Based on their title, abstract and keywords, the main focus of each publication was identified and a short description of why the publication was accepted for each category was noted for each publication. Publications which fitted into more than one category were only considered under the most relevant category identified by reading the abstract.

The mapping process described here provided a wide overview of the prior research on KMS and e-Learning. From the results presented in Table 3.7, it is evident that most of the research had been focused on designing guidelines for design and implementation (56), architectural models (32), and technology or tools (32). The 56 publications categorised as concerning guidelines for design and implementation included 7 publications on the standardisation of KM and e-Learning. A further 12 publications related to frameworks for the development of Learning Management Systems, Knowledge Management Systems and e-Learning systems.

Application features for use in sectors such as health, maritime, military and education were described in eight of the publications. Those which were classified as dealing with architectural models (32) included models for personalisation, performance analysis, learning activity systems, interdisciplinary and integrative frameworks, intelligent tutoring, collaborative learning, context aware models, generic content models and blended learning. Properties of publications under the criteria ‘technology or tools’ (32) included works on customisation, social navigation, mobile learning, digital video, executing experimental activities, authoring, deployment and evaluation, content reusability and automated sequencing, the application of mining and fuzzy techniques, the usage of multi agent systems and open-source systems, and the implications of collaborative and peer learning.

The low number of publications falling under the categories conceptual framework (6), quality aspects (4), theoretical background (2) ontology based applications (9), evaluation (13), case study (12), assessing learning effectiveness (9) and literature survey (0) indicated a relative lack of research on these areas. Since the main objective of this research was to devise a quality assessment framework, the categories of quality aspects, evaluation, and assessing learning effectiveness were deemed to represent the baseline for the Systematic Literature Review (SLR). The publications concerning quality aspects (4) focused on quality assurance, quality dimensions and best practices, while those on evaluation (13) examined success factors, perceptions, outcomes, motivators, pedagogical strategies and usability. In categorising publications into those assessing learning effectiveness (9), the properties considered included behaviour analysis, online persistence, students’ perceptions, learners' satisfaction, students’ motivation, students' evaluation, disseminative capacity, and students' experience.

The mapping study revealed a significant lack of research on the learning effectiveness and quality aspects of knowledge management software (Gunathilake and Neligwa, 2013b). This justified the need for further research into these key aspects of the KMS and e-Learning environments, and the remaining research questions of the current study were therefore formulated to further investigate the quality aspects of knowledge management software, examinations of which were scarce in the existing literature.

**RQ2: What does quality mean in relation to KMS or e-Learning Systems?**

RQ2 was devised to investigate what quality means in the context of KMS or e-Learning systems. The search string mentioned in Table 3.2 for RQ2 was used in an automatic search of the electronic databases. The 25 publications selected for full paper review were chosen by considering the title, abstract and keywords searched for and resulted in the following numbers from each of the electronic databases: ScienceDirect (7), EBSCOhost (7), ACM (3), ISI Web of Knowledge (5) and SpringerLink (0). Three publications were repeated in the different digital libraries. Of the 22 publications included which related to quality assessment for RQ2, 20 publications met the minimum quality score. The concept of quality is considered in different ways in each of these publications; five of them gave general definitions of quality such as “fitness for use”, “meeting the specifications” and “customer satisfaction”. As has been stated (Alexander and Golja, 2007), “the nature of quality can be characterised as follows: relates to values; entails criteria that are used and developed to make value judgments; and is derived and shaped over time”. Other authors (Dan and Cristian, 2006) have claimed that quality in the software development process is the key to high quality e-Learning software; this means that quality is defined in relation to product and process quality. “We can construct an environment which supports the development of quality on-line programs by using a combination of Total Quality Management and current best practice” (Darbyshire, 2003); defining quality in KMS or e-Learning systems can be difficult due to the subjective nature of quality in different settings. This literature review provided evidence for a lack of definitive metrics for defining quality (Darbyshire, 2003). The main quality focuses discussed in the located publications were attributes of quality, models for quality assessment, Total Quality Management, and recommendations for quality assessment, and a summary of each of them is given in Appendix 3.4.

Overall, an analysis of the 20 publications showed that none of the prior publications could answer RQ2 directly. KMS or e-Learning systems facilitate the specific needs of an organisation in managing knowledge in ways which are far beyond those provided by any other information system. The need to define the quality of the KMS or e-learning systems themselves is therefore identified as a key factor for future research on the quality assessment KMS or e-Learning systems to consider.

**RQ3: What are the quality attributes of KMS or e-Learning software?**

For a further analysis of quality assessment in KMS or e-Learning software, it is important to identify the actual attributes of quality. RQ3 was devised for this purpose and the search string mentioned in Table 3.2 for RQ3 was used in the automatic searches of the electronic databases, and the large number of publications retrieved in the early stages was then refined by considering the inclusion and exclusion criteria. Finally, a total of thirteen publications were selected for full paper review from the electronic databases as follows: ScienceDirect (5), EBSCOhost (4), ACM (3), ISI Web of Knowledge (1) and Springerlink (0). The publications reporting each quality attribute are given in Appendix 3.5.

Different factors are considered in categorising quality attributes: quality benchmarks, parameters of quality, and critical success factors. As has previously been explained (Govindasamy, 2001), a set of quality benchmarks can be distributed along seven parameters: institutional support, course development, teaching and learning, course structure, student support, faculty support, and evaluation and assessment. The quality attributes to be evaluated in e-Learning systems are system quality, knowledge or information quality, perceived KMS benefits, user satisfaction, and system use (Wu and Wang, 2006). The critical success factors in web supported learning are institutional factors, technology factors, lecturer factors, student factors, instructional design factors and pedagogical factors (Fresen and Boyd, 2005); these factors give an indication of the diverse nature of quality attributes when considering different aspects of knowledge management software.

One previous study grouped fourteen quality dimensions into three quality factors in assessing information quality in e-Learning systems: intrinsic, contextual representation and accessibility (Alkhattabi et al., 2011). In this framework, the three intrinsic quality factors are: objectivity, accuracy, and believability; the seven contextual representation quality factors are conciseness, verifiability, representational consistency, understandability, amount of information, reputation, and completeness, and the three accessibility quality factors are: availability, relevancy, accessibility and response time.

The attributes of quality have been explained by considering the determinants of the intention to continue using an e-Learning system (Ramayah et al., 2010). These are identified as relating to system quality, information quality, and service quality. A similar categorisation is described with regard to the attributes linked to an increased likelihood of adoption and implementation of LMS (Black et al., 2007), which are identified as compatibility, relative advantage, trialability, complexity, and observability. The findings of another prior study (Adeyinka and Mutula, 2010) suggested that content quality, system quality, support service quality, teaching and learning quality, self-regulated learning, intention to use, user satisfaction, and net benefits are each important factors in evaluating the success of a WebCT e-Learning system.

An empirically validated knowledge management success model (Kulkarni et al., 2007) identified explicit knowledge use, the perceived usefulness of knowledge sharing, user satisfaction, knowledge content quality, KM system quality and organisational support as the attributes of quality in a KMS, while another study (Ellis and Calvo, 2007) suggested that the minimum indicators assuring the quality of LMS-supported blended learning are leadership, policy, problem management, staff development, user support, and evaluation. The need to identify the attributes of quality in relation to this special type of software is clarified in the statement that: "Assessing quality in online teaching is problematic, both due to a lack of agreement over standards and criteria for assessing learning outcomes, and for mixed mode teaching, an inability to separate the learning that occurs online from that which occurs in other environments" (Weaver et al., 2008). The relationship between e-Learners' self-regulatory efficacy and perceptions of e-Learning environmental quality can be evaluated with reference to perceived ease of use, perceived usefulness, information contextual quality, information representational quality, service quality, self-regulatory efficacy, satisfaction, and academic performance (Lee and Lee, 2008). Further, an empirical investigation (Ozkan and Koseler, 2009) identified the following six dimensions of quality: system quality, service quality, content quality, learner perspective, instructor attitudes, and supportive issues. Tutor quality, perceived usefulness, and facilitating conditions were identified as the attributes of quality in E-Learning Acceptance Measure (ELAM) (Teo, 2010).

KMS or e-Learning software is a specialised type of software which should have the attributes of software quality as well as the attributes of quality in an educational environment. From the SLR results for RQ3, the need to identify the attributes that can fulfil the quality aspects specifically needed for software used for learning purposes is emphasised. Table 3.8 displays the quality attributes identified through the results for RQ3. The 41 quality attributes identified in the study were categorised into content quality, platform quality, or user satisfaction. The frequency of occurrence of each quality attribute is presented in Table 3.8, and a brief description of the quality attributes is given in Appendix 2.3. The results in relation to RQ3 were used in devising the proposed framework for assessing the quality of KMS and e-Learning software in this research.

| Quality attribute | | Frequency (n=12) | Percentage of frequency (%) |
|---|---|---|---|
| **Content quality** | | | |
| 1 | Content representation | 6 | 50 |
| 2 | Consistency | 2 | 16.67 |
| 3 | flexibility | 2 | 16.67 |
| 4 | Interactivity | 2 | 16.67 |
| 5 | Learning model | 2 | 16.67 |
| 6 | Clarity | 2 | 16.67 |
| 7 | Understandability | 4 | 33.33 |
| 8 | Tutorial structure | 3 | 25 |
| 9 | Up-to-datedness | 5 | 41.67 |
| 10 | Learner assessment quality | 3 | 25 |
| 11 | Well-organised | 3 | 25 |
| 12 | Completeness | 5 | 41.67 |
| 13 | Relevancy | 5 | 41.67 |
| 14 | Accuracy | 5 | 41.67 |
| 15 | Teaching and learning | 5 | 41.67 |
| 16 | Reliability | 5 | 41.67 |
| 17 | Information contextual quality | 7 | 58.33 |
| 18 | Self-regulated learning | 4 | 33.33 |
| 19 | Usefulness | 5 | 41.67 |
| 20 | Academic performance | 3 | 25 |
| **Platform quality** | | | |
| 21 | Easy to use | 7 | 58.33 |
| 22 | Security | 3 | 25 |
| 23 | Reliability | 4 | 33.33 |
| 24 | Usability | 2 | 16.67 |
| 25 | Help option available | 2 | 16.67 |
| 26 | User friendly | 2 | 16.67 |
| 27 | Well-organised | 2 | 16.67 |
| 28 | Availability | 5 | 41.67 |
| 29 | Personalisation | 2 | 16.67 |
| 30 | Interactivity | 1 | 8.33 |
| 31 | Accessibility | 4 | 33.33 |

| | | | |
|---|---|---|---|
| 32 | Response time | 5 | 41.67 |
| 33 | Easy to communicate | 3 | 25 |
| **User satisfaction** | | | |
| 34 | Efficiency and effectiveness | 5 | 41.67 |
| 35 | Intention to use | 4 | 33.33 |
| 36 | Learner attitudes toward KMSS | 2 | 16.67 |
| 37 | Enjoyable experience | 2 | 16.67 |
| 38 | Learners' study habits | 3 | 25 |
| 39 | Motivation/commitment/self esteem | 3 | 25 |
| 40 | Communication with fellow learners | 4 | 33.33 |
| 41 | Time management/time on task | 3 | 25 |

Table 3.8 Quality attributes of knowledge management software

**RQ4: What are the methods of assessing quality in KMS or e-Learning software?**

Twenty previous publications have reported methods of assessing quality in KMS or e-Learning software. The categorisation of these publications based on the methods they used to assess quality is given in Table 3.9.

| Method of assessing quality | Publications |
|---|---|
| Survey | (Fresen and Boyd, 2005), (Alkhattabi et al., 2011), (Ellis and Calvo, 2007), (Darbyshire, 2003), (Weaver et al., 2008), (Ozkan and Koseler, 2009), (Georgouli et al., 2008), (Teo, 2010) |
| Benchmarking | (Alexander and Golja, 2007) |
| By measuring self-regulatory efficacy | (Lee and Lee, 2008) |
| Empirically testing | (Wu and Wang, 2006), (Concannon et al., 2005), (Pah et al., 2008) |
| Smart algorithm | (Cavus, 2010), (Buyukozkan et al., 2010) |
| Community of Inquiry | (Nagel and Kotzé, 2010) |
| Measurement framework | (Connolly et al., 2005) |
| Using quality assurance measures | (Moussa and Moussa, 2009), (Pond, 2001), (Fardoun et al., 2009) |

Table 3.9 Methods of assessing quality as reported in prior publications

The categorisation in Table 3.9 was further analysed to identify the method of assessing quality used by each study. Detailed descriptions are given in Appendix 3.6.

Of the 20 publications, survey was found to be the most common method (8 publications) used in assessing quality. The different types of surveys used include online questionnaire surveys on student satisfaction, institution-wide surveys on use of e-Learning or KMS, and surveys on the usefulness of information on systems and learners' performance assessment. Another common method for assessing quality is using quality assurance measures, which are used in international quality management systems or institutional quality assurance systems. Other methods which have been employed are benchmarking, hypothesis testing, and indicators such as self-efficacy, and Community of Inquiry. Some specialised methods identified through this literature review include smart fuzzy logic algorithms, and measurement frameworks.

**RQ5: How is learning effectiveness measured in KMS or e-Learning systems?**

Learning effectiveness is identified as an essential parameter for assessing quality in KMS or e-Learning systems. RQ5 was devised to analyse the methods used to measure learning effectiveness. After reading full papers, 45 relevant publications found using the ScienceDirect (13), EBSCOhost (10), ACM (4), ISI Web of Knowledge (14) and Springerlink (4) electronic databases were selected to identify the methods used to measure learning effectiveness in KMS or e-Learning systems. The method each publication used to evaluate learning effectiveness is given in Appendix 3.7. Nearly 50% of the publications (i.e. 22 in total) used surveys to evaluate learning effectiveness. Performance evaluation by auditing the knowledge gained in group work in e-Learning environment has also been reported (Fernández-Breis et al., 2009). As explained by another previous study (Martínez et al., 2007), evaluating learning effectiveness can also be done through qualitative analysis of messages written by participants in the virtual environment. The use of a formative assessment system, as deployed in traditional learning environments, has also been explained by Wang (Wang, 2008), (Wang, 2007). A case study method has also been proposed which can be used to explore if, and how, the use of technology can increase the level of interactivity in distance educations and thereby enable a change in learning culture (Andersson and Hatakka, 2010).

A specialised method for evaluating learning effectiveness is a skill assessment package called Communication Abstraction Layer (ComAL) (Gierlowski and Nowicki, 2009). A case for using "intent to use" as a measure of KM/KMS success has also been put forward (Jennex, 2008). Further, a Community-based Reference Model has been reported for the development of services within a large service-oriented e-Learning assessment framework (Wills et al., 2009); relatedly, one aspect of school knowledge management framework to facilitate teacher learning and improve teacher professional development by establishing a performance assessment mechanism relating to knowledge applications and development (Zhao, 2010). An evaluation process based on a gradual approach starting with an analysis of the form of the solution proposed by the learner has been proposed (Bouarab-Dahmani et al., 2010), in which a semantic analysis detects the semantic errors that render the learner's solution inadequate to the exercise statement.

Content rating schemes (in which KMS users submit ratings to indicate the quality of specific content used) and credibility indicators (indicators describing the validity of the content and/or the ratings) can be used to improve users' searches and evaluation of KMS content; one prior study (Jara and Mellar, 2010) examined how content ratings and credibility indicators affect KMS users' searches and evaluation processes and decision performance (in terms of how well and how quickly users selected the alternatives offered by the KMS).

Another suggested method (Kalyuga and Sweller, 2005) is the evaluation of learner expertise based on an assessment of the content of working memory, and the extent to which cognitive load has been reduced by the knowledge retrieved from long-term memory. This method was tested in an experiment with an elementary algebra tutor. Moving on, applying social networks to enhance the quality of e-Learning in terms of knowledge sharing in a virtual learning community can overcome two barriers: the difficulty of finding quality knowledge, and the difficulty of finding trustworthy learning collaborators (Yang et al., 2007). The results of this research demonstrate that applying such mechanisms to knowledge sharing improves the quality of e-Learning in virtual learning communities. An empirical study (Zhang et al., 2006) has examined the influence of interactive video on learning outcomes and learner satisfaction in e-Learning environments. Four different settings were studied; e-Learning environments with interactive video, with non-interactive video and without video, along with the traditional classroom environment. The results of the experiment showed that the value of video in learning effectiveness was contingent upon the provision of interactivity. Students in the e-Learning environment with interactive video achieved significantly better learning performance and higher levels of learner satisfaction than those in other settings. However, students in the e-Learning environment with non-interactive video did not improve in either of these respects.

The importance of the psychological process of learning in evaluating learning effectiveness has also been emphasised (Zhang et al., 2010) in a study which applied cognitive learning theory in designing an E-Learning course in order to analyse the psychological process of learning when a learner learns a course, and to test how the psychological process of learning is affected by different learning methods. The results of three small scale studies carried out in a tertiary education department, to assess the educational environment is described in (Konstantinidis et al., 2009). This environment was evaluated based on a hybrid evaluation methodology for uncovering usability problems, collecting further requirements for additional functionality to support collaborative virtual learning environments, and determining the appropriateness of different kinds of learning scenarios.

An extensive empirical study (Tsianos et al., 2010) was conducted in order to evaluate the role of Working Memory (WM) span in educational hypermedia and, more centrally, to assess the effectiveness of corresponding personalisation techniques in terms of actually assisting learners with low levels of WM span in improving their performance. As has been stated, "the term working memory refers to a brain system that provides temporary storage and manipulation of the information necessary for such complex cognitive tasks as language comprehension, learning, and reasoning" (Tsianos et al., 2010). Another study used a measurement framework to assess adaptive performance by focusing on the alignment of adaptation methods with usage and business factors (Ounaies et al., 2008), an approach which can be used to measure learning effectiveness. Adaptation systems aim to provide personalised services to users by allowing the user to change certain system parameters in order to adapt their behaviour accordingly.

Based on the evidence gathered for RQ5, the main methods used to evaluate learning effectiveness can be summarised as questionnaire surveys, case studies, empirical evaluations, multi criteria decision making models, formative assessment, web-based software for evaluation, and measurement frameworks. The various methods reported in the 45 publications discussed above provide evidence regarding the diverse nature of the factors which require consideration in evaluating the learning effectiveness of KMS or e-Learning systems. The findings relating to RQ5 provide the basis for the selection of methods to assess learning effectiveness in a KMS or e-Learning environment, as is later described in Chapter 5.

### 3.4 Limitations of the SLR

The main limitations of this SLR are the potential for bias in the selection of publications and for inaccuracy in the data extraction process. To help to ensure that the process of selection was free of bias, a research protocol was developed in advance that defined the research questions. The review mainly employed electronic resources, so using these questions as a basis, keywords and search terms that could enable the relevant literature to be efficiently searched were identified. These were developed after implementing trial searches, by consulting experts, and simply by using a thesaurus. Due to the choice of keywords and search strings, there was a risk that some relevant studies might be omitted. To avoid a selection bias, every part of the review process was pilot tested. In particular, the search strategy and citation management procedure was tested repeatedly to clarify any weaknesses and refine the selection process. The data extraction process may have also been negatively impacted by bias when selecting the articles because the data extraction procedure was performed by a single reviewer. However, the development of an SLR protocol and the use of a sample quality checking strategy (by a second reviewer) helped to ensure that this was not the case. Finally, it is possible that the inclusion and exclusion criteria may have inadvertently excluded some relevant resources.

### 3.5 Reflections on the Systematic Literature Review

A Systematic Literature Review (SLR) is well defined methodology compared to other forms of literature review. The reflections offered here on conducting this SLR and on each stage of SLR process might be useful in conducting a SLR for any type of research project (Gunathilake and Neligwa, 2013a). As a PhD student, this SLR gave the researcher an opportunity to learn many lessons in carrying out a thorough literature review for a research. Adopting the guidelines previously set out for SLR (Kitchenham, 2007) helped in successfully completing the SLR process. Furthermore, advice was followed (Woodall, 2006) and a stepwise refinement approach adopted when developing the SLR protocol, and these steps helped to ensure that the process was suitably rigorous and appropriate for the task.

Good time management skills, productive discussions with supervisors and seeking and receiving advice at each stage of the SLR process were essential for the timely completion of the SLR. Any potential risks and delays in the SLR project should be identified in advance; in this case, through the use of proper project management and time management skills, the SLR was completed within six months. Though it was time consuming, ensuring the validity of the literature review is one of the most important factors in carrying out a SLR, so it is essential to be patient in completing each stage until the expected results are achieved. In order to eliminate the repetition of some steps (e.g. searching for publications), pilot testing and discussing the drawbacks of each step with another reviewer proved helpful. The tools provided by digital libraries in refining publications should be carefully selected in order to extract the highest number of closely related articles for the review. Since conducting a SLR requires the careful reading of a large amount of publications, special notes must be taken while reading the publications which will be useful in future stages of the research.

### 3.6 Summary

The review of the literature that was undertaken to investigate the existing research areas of knowledge management, with particular reference to the quality assessment of knowledge management software, has been described and reported in this chapter. The related prior publications on the quality assessment of KMS were analysed using the Systematic Literature Review (SLR) methodology. SLRs are different from standard literature reviews as they offer a more trustworthy, rigorous and auditable approach and the gaps in existing research can be clearly identified. The SLR reported in this chapter is the first of its kind to focus on the quality assessment of KMS. Its results provide the justification for the stages of this research reported in this thesis.

The SLR protocol, developed at an early stage of this literature review, was executed as described in this chapter. During the SLR, publications were searched for in five electronic databases. After applying the inclusion and exclusion criteria and performing validation exercises for the quality assessment of the located publications through a pre-defined set of criteria, 81 publications were accepted into the final set of included literature. Answers to five research questions were reached through the SLR.

The first research question (RQ1), which was formulated to identify the existing research on KMS, was answered through a mapping study. 276 publications on KMS were identified for this research question, of which 176 publications were categorised into 11 research area categories. This mapping study highlighted the lack of prior research on the quality assessment of KMS and therefore justified the need for new research of this kind undertaken here. The remaining 100 publications will be categorised in future research with publications added to the body of knowledge after conducting this mapping. The second research question (RQ2) was formulated to identify what quality means in relation to KMS or e-Learning software. Based on the 20 publications identified for RQ2, it was evident that no exact answer to this question has yet been provided, and that defining quality in the context of KMS or e-Learning software is an essential task for the future research on KMS. Based on the findings addressing the third research question (RQ3), the quality attributes of KMS could be identified. By analysing 12 publications which explored the quality attributes of KMS, 41 such attributes were identified. These attributes were categorised as relating to content quality (20), platform quality (13), and user satisfaction (8). The results for the fourth research question (RQ4) identified methods of assessing the quality of KMS software. Of the 20 publications which fulfilled the validation criteria for this research question, the questionnaire survey was the most common method (8 publications) used in the quality assessment of KMS software. The findings for RQ4 were applied to evaluate the KMSS prototype designed for this research (described in Chapter 5), bearing in mind that learning is the key function of managing knowledge, and that learning effectiveness is crucial to the quality of knowledge management software. In order to assess the quality of KMS, identifying the best methods of evaluating learning effectiveness is essential. The answer to the fifth research question (RQ5) provided evidence on the various methods of evaluating the learning effectiveness of KMS. By analysing 45 studies, the main methods used in evaluating learning effectiveness could be identified as questionnaire surveys, case studies, empirical evaluations, multi criteria decision making models, formative assessment, web-based software for evaluation, and measurement frameworks. From among these methods, questionnaire surveys were reported as the most commonly-used method for evaluating the learning effectiveness of KMS software.

In addition to the SLR process and results, this chapter also described the limitations of the SLR and the measures taken to ensure its validity and reliability. Finally, some reflections intended to be useful to future conductors of SLRs were presented. The results of this SLR were used as the basis for formalising a quality assessment framework for knowledge management software (described in Chapter 6).

# Chapter 4: Overview of learning theories

## 4.1 Chapter synopsis and outline

The quality attributes of knowledge management software were identified through the SLR described in the previous chapter. In order to strengthen the validity of the identified quality attributes, a further stage of data collection in the form of an evaluation of KMS software was incorporated into the research. These experimental data are one of the main sources for the formalisation of the quality assessment framework described in Chapter 6. A KMSS prototype was used as the test bed for data collection in the form of an evaluation of knowledge management software.

As described in Chapter 1, learning is the key function in managing knowledge, and learning effectiveness is crucial in assessing the quality of knowledge management software(Henschke and Charungkaittikul, 2011, Alamäki and Mäkinen, 2005). In order to improve the effectiveness of learning, the learning environment in the context of knowledge management software should be designed according to the basics of learning. Learning theories have provided some guiding principles for designing an ideal learning environment for knowledge management software. The main purpose of this chapter is to give an overview of the learning theories in relation to designing, developing and implementing a KMSS prototype (a process which is described in chapter 5). This chapter meets objective three of this study, and is organised as follows:

- An overview of learning theories is set out in Section 4.2.
- Section 4.3 describes the application of learning theories in designing a learning environment for a KMS platform.
- The limitations of the overview of learning theories are described in Section 4.4.

- A summary of this chapter is given in Section 4.5.

### 4.2 Overview of learning theories

As has been mentioned in previous chapters, knowledge is gained through learning. KMS software is used for learning, and therefore, learning is one of the key functions in managing knowledge effectively. In particular, the learning environment in relation to KMS software provides a foundation for learning. Designing a suitable learning environment based on learning theories will enhance the quality of the learning, reduce ineffectiveness, and boost positive outcomes (Thurmond, 2002). In this research, learning theories were considered as guiding principles in the design, development and implementation of appropriate teaching and learning activities to enhance the quality of learning through KMS software.

There has always been a relationship between theory and design, or between science and technology (Wilson, 1997). In order to maximise effectiveness, instructional design must map, to the fullest possible degree, the underlying theories that shaped the design approach. Education, at its core, is about change, and instructional design is the science of building instruction which fosters that change. In order to improve how and how well learners are educated, it is crucial to create an actual link between theory and practice (Spector, 2000). More concisely, theory and design must intersect if instruction is to be successful. Learning theories provide instructional designers with verified instructional strategies and techniques for facilitating learning, as well as a foundation for intelligent strategy selection (Ertmer and Newby, 1993). The information presented in this chapter provides a comparison of the different viewpoints adopted in learning theories, and an assessment of the most suitable learning theory for designing a learner-centred constructive learning environment for knowledge management software.

The three main learning theories are behaviourism, cognitivism and constructivism. Each learning perspective can be considered in terms of its specific interpretation of the learning process and the resulting implications for instructional designers and educational practitioners (Ertmer and Newby, 1993). This section gives an overview of these three prominent learning theories.

**Behaviourism**

Behaviourism was dominant in the 1950s, when instructional design first arose as a professional discipline. According to behaviourism, external factors shape learning rather than the characteristics of the individual learner doing so. Learning is sequential and hierarchical and occurs by accumulating its elemental building blocks, and the most critical factor affecting learning is "how the association between the stimulus and response is made, strengthened, and maintained" (Ertmer and Newby, 1993). This theory was used as the basis for the creation of many audio-visual materials, as well as Skinner's teaching machines. Some examples of behaviourism's influence on learning are computer-assisted instruction (CAI) and mastery learning. Behaviourism concentrates on the study of overt behaviours that can be observed and measured (Good and Brophy, 1990), and views the mind as a "black box" in the sense that a learner's response to stimulus can be observed quantitatively, ignoring the possibility of thought processes occurring in the mind. As suggested by Ertmer and Newbie (1993), important principles when designing instruction include the production of observable and measurable outcomes in learners which can be used to measure progress when assessing the learners being educated using these educational approaches. Outcomes are also considered in the assessment of learners in determining where instruction should begin, when mastery of the early steps has occurred before progressing to more complex levels, whether and when reinforcement to improve performance is necessary, and when cues should be selected to ensure a strong stimulus-response association.

**Cognitivism**

It has been observed that "Cognitive theorists recognise that much learning involves associations established through contiguity and repetition. They also acknowledge the importance of reinforcement, although they stress its role in providing feedback about the correctness of responses over its role as a motivator. However, even while accepting such behaviouristic concepts, cognitive theorists view learning as involving the acquisition or reorganisation of the cognitive structures through which humans process and store information." (Good and Brophy, 1990).

A shift occurred in the late 1950s toward learning theories and models from the cognitive sciences. Educators began to place less emphasis on overt, observable behaviour, and instead concentrated more on complex cognitive processes and internal mental processes such as information acquisition, processing, storage and memory, which are vital to learning. Cognitivists focus on how information is received, organised, stored, and retrieved by the mind. Their concern is not with what learners do, but rather with what they know and how they come to acquire what they know (Ertmer and Newby, 1993).

The main focus of the cognitive approach is on changing the learner by encouraging him/her to use appropriate learning strategies. The key factors to be considered when designing instruction include involving the learner in the learning process, organising and sequencing information in order to facilitate optimal processing, and creating learning environments that allow and encourage learners to make connections with previously-learned material (Ertmer and Newby, 1993).

Both cognitivists and behaviourists share the same goal, which is to “communicate or transfer knowledge to learners in the most efficient, effective manner possible” (Bernard et al., 1991). Further, in both the behaviourist and cognitivist views, knowledge can be analysed, decomposed and simplified into basic building blocks so that irrelevant information is eliminated. A fundamental difference between the two, however, is that while behaviourists focus on a well-designed environment, cognitivists emphasise efficient processing strategies.

**Constructivism**

Constructivism is based on the premise that we all construct our own perspective of the world through individual experiences and schema. It focuses on preparing the learner to problem solve in ambiguous situations (Al-Huneidi and Schreurs, 2013).

Constructivists believe that “knowledge is a function of how the individual creates meaning from his or her experiences; it is not a function of what someone else says is true” (Jonassen et al., 1995, Dakich, 2014). They do not share the belief analogous to behaviourists and cognitivists that knowledge is mind-independent, and that it can be mapped onto a learner. Rather, they believe that humans create meaning rather than simply acquiring it. Both the learner and the environmental factors are critical, and the interaction between these two factors is what creates knowledge.

When developing a learning environment, constructivism theory specifies that designers must create stimulating environments that capture learners’ attention and enable them to formulate knowledge and derive meaning for themselves. These environments should allow for collaboration (between learners and the instructor) and encourage meaningful dialogues in order that understanding can be individually constructed. In terms of evaluation, from a constructivist point of view there is no single solution to a problem and learners are encouraged to justify their own solutions, and to show how they arrived at them. A considerable amount of self-reflection therefore occurs. Writing in journals, for example, provides a means for learners to think about what they have learned and give examples from their own experiences. Evaluation is an ongoing process that is part of the learning process rather than only coming at the end of a course.

Honebein (1996) advanced a set of goals that aid constructivist design in learning settings. These goals are to: "provide experience with the knowledge construction process; provide experience in and appreciation for multiple perspectives; embed learning in realistic and relevant contexts; encourage ownership and voice in the learning process; embed learning in social experience; encourage the use of multiple modes of representation; and encourage self-awareness in the knowledge construction process" (Koohang et al., 2009, Honebein, 1996). These goals provided the basis for designing the learning environment for the KMSS prototype developed in this study.

An excellent summary of the characteristics of constructivism learning theory based on a comprehensive review of literature has been presented in a previous study (Murphy et al., 1998). These characteristics are as follows:

- "Multiple perspectives and representations of concepts and content are presented and encouraged.
- Goals and objectives are derived by the learner or in negotiation with the teacher or system.
- Teachers serve in the role of guides, monitors, coaches, tutors and facilitators.
- Activities, opportunities, tools and environments are provided to encourage metacognition, self-analysis, regulation, reflection and awareness.
- The learner plays a central role in mediating and controlling learning.

- Learning situations, environments, skills, content and tasks are relevant, realistic, authentic and represent the natural complexities of the 'real world'.
- Primary sources of data are used in order to ensure authenticity and real-world complexity.
- Knowledge construction and not reproduction is emphasised.
- This construction takes place in individual contexts and through social negotiation, collaboration and experience.
- The learner's previous knowledge constructions, beliefs and attitudes are considered in the knowledge construction process.
- Problem-solving, higher-order thinking skills and deep understanding are emphasised.
- Errors provide the opportunity for insight into learners' previous knowledge constructions.
- Exploration is a favoured approach in order to encourage learners to seek knowledge independently and to manage the pursuit of their goals.
- Learners are provided with the opportunity for apprenticeship learning in which there is an increasing complexity of tasks, skills and knowledge acquisition.
- Knowledge complexity is reflected in an emphasis on conceptual interrelatedness and interdisciplinary learning.
- Collaborative and cooperative learning are favoured in order to expose the learner to alternative viewpoints.
- Scaffolding is facilitated to help learners perform just beyond the limits of their ability.
- Assessment is authentic and interwoven with teaching." (Murphy et al., 1998)

After having compared and contrasted behaviourism, cognitivism and constructivism, it is evident that the instructional approach deployed for novice learners may not be sufficiently stimulating for a learner who is already familiar with the content (Ertmer and Newby, 1993). An instructional strategy should therefore be selected, and the content addressed must depend on the level of the learners. Learning theories should be matched with the content to be learned:

- A behavioural approach can effectively facilitate the mastery of the content of a profession (*knowing what*); cognitive strategies are useful in teaching problem-solving tactics where defined facts and rules are applied in unfamiliar situations (*knowing how*); and constructivist strategies are especially suited to dealing with ill-defined problems through reflection-in-action.
- Behavioural tasks requiring a low degree of processing (e.g. basic paired associations, discriminations, rote memorisation) seem to be facilitated by the strategies most frequently associated with a behavioural outlook (e.g. stimulus-response, or contiguity of feedback/reinforcement).
- Cognitive tasks requiring an increased level of processing (e.g. classifications, rule or procedural executions) are primarily associated with strategies possessing a stronger cognitive emphasis (e.g. schematic organisation, analogical reasoning, algorithmic problem solving).
- Constructive tasks demanding high levels of processing (e.g. heuristic problem solving, personal selection, and the monitoring of cognitive strategies) are frequently test learned, with strategies advanced by the constructivist perspective (e.g. situated learning, cognitive apprenticeships, social negotiation) (Ertmer and Newby, 1993).

Ertmer and Newby's suggestion that theoretical strategies can complement the learner's level of task knowledge encourages designers to make the best use of all available practical applications of the different learning theories. With this approach, designers are able to draw from a large number of strategies in order to meet a variety of learning situations.

Every individual creates his or her own knowledge upon interacting with a piece of information (an object which represents certain knowledge) based on his or her existing knowledge (Shuell, 1992, Zainuddin, 2007) Knowledge that is shared through collaboration within a group will become group knowledge, and knowledge that is accepted at the organisational level is the organisation's knowledge. From the constructivist principle, this knowledge is localised and context-specific. Individuals, groups, organisations, or communities may each have their own unique knowledge of an event or phenomena. Knowledge that is created is a function of the existing knowledge which an individual, group or organisation already possessed. Teaching and learning techniques rooted in constructivism are thought to be more successful because they explicitly address the inevitable process of knowledge construction (Zainuddin, 2007). Constructivism provides a clear, theory-based approach to designing learning (Cunningham, 1991), and, given the nature and objectives of knowledge management software, it has many useful features that can be used as the framework for providing a suitable learning environment for knowledge management software.

Any technology must enable learners to be engaged in meaningful learning (Jonassen et al., 1995), the characteristics of which that must be used as guidelines when designing Constructivist Learning Environments (CLEs) are shown below in Figure 4.1.

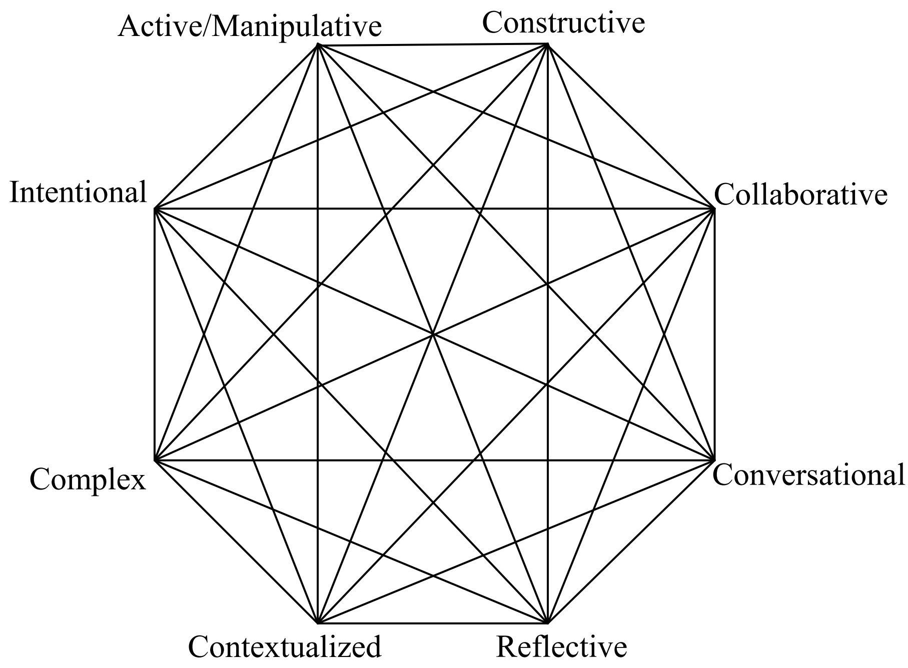


Figure 4.1 Constructivist learning environments (Jonassen et al., 1995)

An overview of features of constructivist learning environment shown in Figure 4.1 is given below.

- Active: Learners are engaged by the learning process in the mindful processing of information, where they are responsible for the result. In natural learning situations, learners and performers of all ages can acquire sophisticated skills and advanced knowledge about what they are learning, without the intervention of formal instruction.

- Constructive: Learners integrate new ideas with prior knowledge in order to make sense or make meaning, reconcile a discrepancy, or satisfy their curiosity or puzzlement. They construct their own meaning for different phenomena.

- Collaborative: Learners naturally work in learning and knowledge building communities, and exploiting each other's skills, while providing social support and modelling and observing the contributions of each member.
- Intentional: All human behaviour is goal directed. That is, everything we do is intended to fulfil some goal. Learning environments need to support learners in articulating what their goals are in any learning situation.
- Complex: The greatest intellectual fault that teachers commit is to oversimplify most ideas in order to make them more easily transmittable to learners. In addition to stripping ideas out of their normal contexts, they also distil ideas down to their simplest form so that learners will be more likely to readily learn them. Complex problems have multiple components and multiple perspectives, and cannot be solved in predictable ways like the canned problems at the end of textbook chapters. Unless learners are required to engage in higher order thinking, they will develop oversimplified views of the world.
- Contextual: A great deal of recent research has shown that learning tasks that are situated in some meaningful real world task, or simulated in some case-based or problem-based learning environment, are not only better understood, but also more consistently transferred to new situations. Rather than abstracting ideas in rules that are memorised and then applied to other canned problems, there is a need to teach knowledge and skills in real life, useful contexts, and to provide new and different contexts for learners to practice using those ideas.
- Conversational: Learning is inherently a social, dialogical process (Cunningham and Duffy, 1996). That is, given a problem or task, people naturally seek out opinions and ideas from others. Technologies can support this conversational process by connecting learners in other locations, and even across the world. When learners

become part of knowledge building communities both in class and outside of school, they learn that there are multiple ways of viewing the world and multiple solutions to most of life's problems.

- Reflective: Learners should be required by technology-based learning to articulate what they are doing, the decisions they make, the strategies they use, and the answers that they find.

Based on the features of constructivist learning theory explained above, the guiding principles for the learning environment in the KMSS prototype of this research are mentioned below:

- Present activities which require learners to recall prior knowledge
- Encourage learners to take responsibility (ownership) for their own learning and to be aware of the knowledge construction process
- Design activities in order of increasing complexity
- Provide opportunities for interaction with other learners and the KMS software
- Design a feedback mechanism to enable learners to be aware of their progress
- Provide support mechanisms for learners through coaching and scaffolding
- Provide a wide range of learning styles
- Use formative and summative assessment to emphasise an ongoing process
- Encourage learners to reach a solution on their own
- Give learners activities in which they can apply the knowledge they have gained

### 4.3 Application of learning theories in designing activities for a KMS platform

Learning effectiveness is considered one of the key aspects defining the quality of KMS software. In this research, a KMSS prototype (designed using the Microsoft Office 365 KMS platform) was used as the test bed for empirical data collection in order to evaluate the effectiveness of learning through knowledge management software. The quality aspects of the KMSS prototype were evaluated through the data collected from a sample of regular users of knowledge management software. The three theoretical foundations considered in developing this learning framework were constructivism theory, learning style theory, and technology integration. Based on the review of the main learning theories given above, constructivism was considered to be the most suitable learning theory for the experiential learning environment developed in this KMSS prototype. In introducing the idea of the experiential learning cycle and of learning styles, the learning style theory by Kolb (Kolb, 1984) defined learning as a process whereby "knowledge is created through the transformation of expertise". The key elements of the experiential approach to learning in this definition are that:

- Learning is a process of adaptation, and not simply a matter of outcomes.
- Knowledge is a continuous transformation process, and not something separately acquired and imparted.
- Knowledge transforms experience both individually and collectively.

The third element in the theoretical framework informing this research was technology. Technology aligned to learning styles is increasingly being used to engage learners and support learning (Solvie and Kloek, 2007). Technology tools also serve to enable learning through the creation of learning objects, and to extend learning by providing “learning by doing” or “learning by seeing” experiences (Bruner and Olson, 1973, Pittman et al., 2006), and they affect the manner in which learners respond to, contribute to and demonstrate understanding of content (Chen et al., 2006). Along with content delivery, this last aspect of technology use for learning is relevant to the role of technology chosen for this study. The technology tools used to create a constructivist setting and shape, model, extend, scaffold and clarification of learning in this study included video and audio, forums, discussion boards, wiki, PowerPoint (presentation software) additional learning materials, quizzes, feedback, searches, blogs, notebook software, calendars, social networking, outlook, and data storage in the cloud.

The concept of "Constructive Alignment" explained by Biggs and Tang (Biggs and Tang, 2011) outlines how to design learning activities for effective learning through knowledge management software. 'Constructive' refers to the idea that learners *construct meaning* through taking part in relevant learning activities. 'Alignment' refers to a learning environment where teaching and learning activities, and assessment tasks, are *aligned* to the intended learning outcomes of a subject. According to Biggs and Tang, there are four steps in designing such teaching and assessment (Biggs and Tang, 2011):

- Describe the *intended outcomes* in the form of the *standards* learners are to attain using appropriate learning verbs.
- Create a *learning environment* likely to bring about the intended outcomes.
- Use *assessment tasks* enabling you to judge if, and how well, learners' performances meet the outcomes.
- Develop *grading criteria* (*rubrics*) for judging the quality of learner performances.

In order to improve the effectiveness of learning through knowledge management software, concepts of constructive alignment were applied in designing the intended learning outcomes, the teaching and learning activities, the assessment tasks, and the grading criteria in the learning environment for the KMSS prototype in this research. Details on the learning environment which was designed according to the principles of constructive alignment are given below, in Chapter 5.

### 4.4 Limitations of overview of learning theories

The purpose of the overview of learning theories set out in this chapter was to identify the role of each of these principles in designing the learning environment for the KMSS prototype. Due to the limited time available to undertake this research, only the most closely relevant learning theories were considered. Some other theories related to learning, such as social constructivism, connectivism and cognitive loading theory were not described in this chapter because constructivism was identified as the most closely related theory through the review. The prototype designed in this research might be further improved by applying some of the key principles of these additional learning theories.

### 4.5 Summary

The quality of knowledge management software is reflected through the effectiveness of the learning it helps to enable. The learning environment is the most important component of knowledge management software that provides a platform for learning. This chapter has provided the theoretical foundations for designing a suitable learning environment for knowledge management software. One of the main sources of information for the formalisation of the quality assessment framework was the data gathered through evaluating the quality attributes of the KMSS prototype designed in this research (described in Chapter 5). The main purpose of the present chapter has been to identify the basics of learning in order to design that KMSS prototype. The three main learning theories discussed in this chapter were behaviourism, cognitivism and constructivism. Based on the review of learning theories which was carried out and discussed in this chapter, constructivism was identified as the most suitable learning theory in designing the learning environment for knowledge management software. Constructive alignment provided the guiding principles for designing, implementing and evaluating the teaching and learning tasks in the constructive learning environment. These principles were incorporated into this research with regard to designing the teaching, learning and assessment tasks for the KMSS prototype. Details of the KMSS prototype which was used as the test bed for data collection in this research are described in Chapter 5.

# Chapter 5: Design, implementation and evaluation of a KMSS prototype

## 5.1 Chapter synopsis and outline

This chapter describes the data collection undertaken through a quality evaluation of knowledge management software, which forms one of the main sources of data used in the formalisation of the quality assessment framework. The purpose of the data collection through the quality evaluation of knowledge management software was to ensure a greater level of validity with regard to the data collected through the SLR (described in Chapter 3).

A KMS platform was selected from a qualitative evaluation of the features and tools of 15 widely-used commercial and open-source KMS platforms. A KMS software (KMSS) prototype was then designed, developed, and implemented using the selected KMS platform. The KMSS prototype plays a key role in this research as a test bed for the empirical data collection on the quality aspects of knowledge management software. The data collection and sample selection methods described in Chapter 2 were applied in evaluation of the quality attributes of the prototype. For the evaluation of the quality attributes of knowledge management software, a sample of regular users of knowledge management software was selected. As has been mentioned throughout this thesis, learning effectiveness has been identified as a key parameter of the quality of knowledge management software. The learning environment in the KMSS prototype was designed according to the learning theories described in Chapter 4, and teaching and learning activities were given to the selected sample of evaluators to carry out using the KMSS prototype.

This chapter fulfils third, fourth and fifth objectives of this research, and describes the qualitative selection of a KMS platform, and the design, implementation and evaluation of the KMSS prototype. The chapter is organised as follows:

- The qualitative selection of a KMS platform is described in Section 5.2
- Section 5.3 describes the design and implementation of the KMSS prototype.
- Section 5.4 discusses the evaluation of the KMSS prototype.
- Threats to the validity and reliability of the study are discussed in Section 5.5.
- The limitations in the design, implementation and evaluation of the KMSS prototype are discussed in Section 5.6.
- Finally, a summary of the chapter is given in Section 5.7.

## 5.2. Qualitative selection of a KMS platform

KMS platforms are available as Course Management Systems (CMS), Learning Management Systems (LMS), Virtual Learning Environments (VLEs), Content Management Systems, Document Management Systems and Office Productivity Software. More than 250 KMS platform providers offer commercial and open-source software (Al-Ajlan and Zedan, 2008). It is important to consider the features of existing KMS platforms in order to select the most suitable product that most closely meets the quality requirements of knowledge management software for any given organisation.

| KMS platforms | URL |
|---|---|
| **Commercial platforms** | |
| Office 365 | www.office365.com |
| Google Apps | www.google.com/Apps |
| Hyper Office | http://www.hyperoffice.com |
| IBM Notes and Domino 9.0.1 | http://www-01.ibm.com |
| WebCT/ BlackBoard 9.1 | http://www.blackboard.com |
| Desire2Learn 10 | http://www.desire2learn.com |
| KEWL | http://sourceforge.net/projects/kewl |
| ANGEL Learning Management Suite (7.4) | http://www.angellearning.com |
| eCollege | http://www.ecollege.com |
| **Open-source platforms** | |
| Moodle 1.8 | http://moodle.org |
| Claroline 1.6 | http://www.claroline.net |
| Dokeos 2.2 | http://www.dokeos.com |
| OLAT 7.0 | http://www.olat.org |
| Sakai 2.3.1 | http://www.sakaiproject.org |
| ATutor 2.1 | http://atutor.ca |

Table 5.1 KMS platforms selected for comparison

The most commonly used commercial and open-source KMS platforms were selected for this comparison, which includes 9 commercial and 6 open-source software platforms as listed in Table 5.1. The more detailed features of each of these KMS platforms are given in Appendix 5.1.

The quality of knowledge management software is an important parameter in assessing its effectiveness for an organisation. In this study, the criteria used in assessing the quality of knowledge management software as identified in the SLR were grouped into three categories: content quality, platform quality and user satisfaction. KMS platforms are available with various tools and features to meet the different requirements of business organisations; these are criteria-based and they enable organisations to select the most suitable KMS platform for their needs. No single KMS platform can meet all these criteria and the most suitable one within any specific context may not be perfect in terms of quality, technical specifications, functionality, or cost (Al-Ajlan and Zedan, 2008). In this study, a qualitative comparison of the features of different KMS platforms was carried out in order to reach a decision on the most suitable KMS platform. The above-mentioned 15 products were selected for comparison after reviewing the features listed on their product websites. Similar comparisons of features and tools across KMS platforms have considered various criteria (Al-Ajlan and Zedan, 2008, Colace et al., 2003, Graf and List, 2005, EduTool, 2012). In the comparison made in the present research, the features and tools available in the different KMS platforms indicating the quality of the knowledge management software, particularly in terms of learning effectiveness, were considered in order to select the most suitable KMS platform to use to design a KMS software (KMSS) prototype. The following section explains the comparison criteria this study used.

### 5.2.1 Criteria for selecting a KMS platform

The quality of a KMS platform is reflected in its tools and features. The availability of the quality attributes identified from the SLR in the selected KMS platform was considered in this comparison. Appendix 5.2 lists 47 features and tools considered in relation to a KMS platform being able to provide a complete learning and teaching experience. The mapping of the quality attributes identified in the SLR onto the features and tools of the various KMS platforms is presented in Appendix 5.3. This mapping exercise provided a basis for the comparison of the KMS platforms. The comparison criteria were selected based on the information given on the product websites of the selected KMS platforms, and similar prior studies (Cheng and Yen, 1998, Dougiamas and Taylor, 2002, O'Leary and Ramsden, 2002, Al-Ajlan and Zedan, 2008) .

### 5.2.2 Comparison of KMS platforms

The comparison of the different features of KMS platforms is presented in Appendix 5.2; according to it, most of the required features are found in Office 365, which is a commercial software program, and also on Moodle, which is open-source software. Open-source systems give users the freedom to develop their required system, and the ability to integrate existing products (Machado and Tao, 2007). However, developing more codes on the open-source system would need more support for maintenance and upgrade. Moodle is open-source and therefore it is free to use, but for training and managing Moodle, organisations require trained staff; this should be compared with Office 365, which requires a license at a cost. It can be argued that the user-friendly features of Microsoft Office 365 overcome the costs involved in training and managing open-source software like Moodle. There are also additional features in Microsoft Office 365 (described in Appendix 5.1) which are important when using it as software for managing knowledge in organisations.

According to the literature on KMS platforms, it is evident that Moodle is the most commonly-used software in this context (Williams and Dougiamas, 2005). Because there is no licensing cost involved with open-source solutions, it is easy for organisations to simply jump in and set up the first solution that comes along. There is, however, a cost for installation and support, which will either be financial or time related. Therefore, when setting up a KMS it is important to research and choose the solution that is right for the organisation. Moodle has the following limitations:

- Moodle is only for IT experts. It is complex for normal users to use and more than 66% of them are teachers, researchers and administrators (Chavan and Pavri, 2004);
- It is difficult for beginner technicians to install and use Moodle due to the technical nature of the instructions (Williams and Dougiamas, 2005);

- Moodle will work, but not by itself. If there is no course administrator to work with both teachers and technicians in creating online materials, then Moodle will remain an empty shell, like a good aircraft with no pilot (Al-Ajlan and Zedan, 2008);
- Moodle suffers from a lack of simple-to-obtain support. Forums carry a great deal of information, but nearly all of these are in English (Chavan and Pavri, 2004).

The major limitations of Moodle listed above are avoided by modern commercial software. The main limitation of commercial software is usually identified as the cost for licensing/the pricing feature. Well-designed knowledge management software is the key to organisational success, so the quality of the KMS platform is arguably more important than the cost for licensing/pricing to any organisation which is willing to implement effective knowledge management software. Among the commercial software in this comparison, Microsoft Office 365 and KEWL have a similar number of features. Microsoft Office 365 is a cloud-based KMS platform which has many additional features in addition to the 47 feature considered for comparison. On the other hand, most of the software on this study's comparison list supports content management, particularly for learners. In managing organisational knowledge, knowledge management software should have many other features in addition to content management. Furthermore, enterprise knowledge management entails formally managing knowledge resources in order to facilitate the access and reuse of knowledge, typically by using advanced information technology (O'Leary, 1998). The overriding purpose of enterprise KM is to make knowledge accessible and reusable to the enterprise. The successful implementation of Microsoft Office 365 in managing knowledge in organisations has previously been reviewed in the literature (Zachry and McCollum, 2007). According to a survey of technology-enhanced learning for higher education in the UK, the number of higher education institutes (HEIs) that are using Microsoft Office 365 either as a corporate portal, or as a general enterprise document management and collaboration system is increasing annually (Tom Browne et al., 2008). Furthermore, it has been reported that Higher Education Institutes such as the University of the West of England, Coventry University and the University of Oxford have large Microsoft Office 365 implementations in place. These applications of Microsoft Office 365 in educational institutes for various purposes can be regarded as strong evidence of its advantages over other KMS platforms in this comparison.

Furthermore, in addition to the features considered for the present comparison, Microsoft Office 365 has many more features supporting knowledge management in organisations. These additional features (listed in Appendix 5.1) reflect the quality requirements expected by the stakeholders of knowledge management software in any organisation. Microsoft Office 365 is therefore selected in this research for use in the design of its KMSS prototype in order to evaluate the quality features of knowledge management software.

### 5.3 Design and implementation of a KMSS prototype

As has been mentioned above, the main purpose in this research of the design and implementation of a KMSS prototype is for use as a test bed for data collection in order to validate the data previously collected through the SLR. Through the investigation of the quality features of existing KMS software, it was evident that none of the KMS software platforms had all of the quality attributes identified in the SLR. A prototype was therefore designed with a view to evaluating the users' perceptions of the quality attributes identified through the SLR. In the KMS software (KMSS) prototype, the quality attributes identified through the SLR were integrated using the tools and features of the Microsoft Office 365 KMS platform (selected based on the qualitative comparison described in the previous section).

This section explains the important factors considered in the design and implementation of the study's KMSS prototype. Because the learning environment in knowledge management software plays a vital role in giving an effective learning experience, the environment in this prototype was carefully developed based on the constructivist learning theory explained in Chapter 4. The main features of Microsoft Office 365 able to provide a constructivist learning environment (illustrated in Figure 4.1 in Chapter4) are SharePoint Online, Exchange Online, Lync Online, as well as Office Professional Plus and Office Web Apps (web-based versions of Excel, Word and PowerPoint). In this research, the learning activities were designed with the use of SharePoint's features and tools, which include a document library, blogs, notice board, user tasks, wiki, help, online notes, etc. The Exchange Online feature is used to deliver secure access to email, calendar, contacts and tasks, while Lync Online is used for enterprise-wide communication in delivering learning content. Office Professional Plus and Office Web Apps are used in preparing learning content (more details of the main features of each of these components are given in Appendix 5.1). The bullet points below list how the tools in KMSS prototype designed using the Microsoft Office 365 KMS platform was used in evaluating its quality attributes (identified in Chapter 3).

- Each user was given a secure login and a personalised page. These features were used to evaluate the platform's quality attributes (e.g. security and personalisation).
- A video tutorial on "Introduction to Database Technology" was provided as a component of the KMSS prototype and used to rate the platform quality, content quality and user satisfaction.
- A practice test and a quiz were designed in order to evaluate how the learner applies the knowledge gained through using the KMSS prototype. These activities were used in evaluating the academic performance quality attribute.
- Announcements, a calendar, help, blogs, an online discussion board and wikis were used to create an efficient and effective learning environment.

The details of how each quality attribute identified in the SLR was reflected in the KMSS prototype are given in Appendix 5.4, while the key features of the KMSS prototype are described in the next section of the thesis. The data collected through the evaluation of the quality attributes of the KMSS prototype are presented in Section 5.4.

### 5.3.1 Main features of the KMSS prototype

The KMSS prototype was designed using Microsoft Office 365 with the learners who use technology for learning in mind. Microsoft Office 365 is claimed by its manufacturer to quickly facilitate the creation and faster use of application-based features using an integrated cloud-based service so that users can access their documents in any location and at any time. Microsoft Office 365 uses a program/storage system called SkyDrive to allow the uploading of files to cloud storage for users to access from any web browser, PC or Mac without the need for manual syncing. The main components of this prototype are a login page, a home page, a notebook, learning materials, a blog, a survey, announcements, a task list, a discussion board, wikis, a calendar, as well as a contact us page, outlook, people, newsfeed, skydrive and sites. The features of the components of the KMSS prototype are given in Appendix 5.5.

### 5.3.2 Design of the learning environment for the KMSS prototype

One of the main components of the KMSS prototype is its learning environment. In designing and implementing the KMSS prototype, the guiding principles emerging from the review of the learning theories described and discussed in Chapter 4 were followed. In the learning environment of the KMSS prototype, a video tutorial was designed to achieve the intended learning outcomes set out in the Introduction to Database Technology. Hands-on practical activities were given to the participants to carry out using MySQL database management software. This tutorial was created for those who are new to Database Technology using MySQL. The ultimate aim of the tutorial is for users to gain understanding of the usage of Database Management Systems in effective data management. The constructive learning environment was created using various features of the Microsoft Office 365 KMS platform such as the video tutorial, quizzes, blogs, wikis, the discussion board, announcements, searches, an interactive graphical user interface, audio and help. The learner can go through the tutorial starting from any place according to their level of knowledge. Quizzes were given at the end of each section so that users could review it, and at the end of the tutorial. Details of the learning environment designed according to the principles of constructive alignment (described in Chapter 4) are given below.

The learning outcomes of the video tutorial were identified by considering the basic knowledge required for a beginner to gain an understanding of database technology, using MySQL to create a database and manipulate the data in that database. The title of the tutorial was: Introduction to Database Technology using MySQL. The content of the video tutorial and practical exercises were developed with reference to the following resources:

- Database Management module content (B.Sc. in Computer Science, School of Commuting and Mathematics, Keele University)
- Database Systems textbook (A Practical Approach to Design, Implementation and Management, Connolly, Thomas M.; Begg, Carolyn E., Published by Addison Wesley, ISBN 10: 0321523067 / ISBN 13: 9780321523068)
- MySQL official web site (URL: http://www.mysql.com)

**Intended Learning Outcomes (ILOs)**

Upon the successful completion of this tutorial, the learner should be able to:

- ILO1: Describe what a database is
- ILO2: Describe the uses of databases
- ILO3: Describe the components of the database management system (DBMS) environment
- ILO4: Create a database using MySQL
- ILO5: Create a table in a database
- ILO6: Retrieve, insert, update and delete data in a table

**Teaching and Learning Activities (TLAs)**

- TLA1: Describe what a database is, with examples (ILO1)
- TLA2: Describe the uses of databases, with examples (ILO2)
- TLA3: Describe the components of a database management system environment, with examples (ILO3)
- TLA4: Explain how to use MySQL, and how to create a database in MySQL (ILO4)
- TLA5: Explain how to create a table in a database (ILO5)
- TLA6: Explain how to retrieve, insert, update, and delete data in a table (ILO6)

The above teaching and learning tasks were given as a video tutorial, and also as review quizzes and practical exercises in MySQL. Additional resources in the KMSS prototype such as wikis, blogs, a discussion board and the notebook were designed to provide a constructive learning environment.

**Assessment Tasks (ATs)**

- AT1: Quiz (ILOs1, 2 and 3) (10 minutes)
- AT2: Practical exercise to create a database using MySQL (ILOs 4, 5 and 6) (30 minutes)

These assessment tasks were used to assess the theoretical and practical knowledge which the participants gained through learning using the KMSS prototype. Appendix 5.6 presents the assessment tasks given in this learning environment.

**Grading criteria**

Based on the total scores for the quiz and the practical test, a grade was assigned to each participant. The marks were evenly split between the quiz and the practical test; for both the quiz and the practical test, the maximum score was 50% and the pass score for each category was 25%. If anyone scored less than 25% for the quiz or practical test, then they were allowed three attempts to gain the minimum pass score for both the quiz and the practical test. With regard to the overall grades, Grade “A” was assigned for a total score greater than or equal to 75%. Grade “B” was assigned for a total score greater than or equal to 65% and less than 75%. Grade “C” was assigned for a total score greater than or equal to 40% and less than 60%, and Grade “D” was assigned if the total score was less than 40%.

### 5.3.3 Main features of the video tutorial in the KMSS prototype

The video tutorial in the KMSS prototype was developed as a piece of interactive self-learning content. At the beginning of the tutorial, information on how to use it and a general introduction to the tutorial was given. The tutorial was structured in the form of the contents of a book, which links to the title. The navigation inside the tutorial involved easy-to-use buttons in each section. A transcript of the content was also given for the learner to follow with the tutorial or after completing the tutorial. Quizzes were given at the end of each section to review the topic discussed in each section. Different types of questions, such as true or false, fill in the blank, word matching, drag and drop, multiple choices, multiple responses and word banks were used in reviewing each section. In order to achieve the intended learning outcomes, the content of the video tutorial was organised into four sections:

- Introduction to Databases (ILOs 1 and 2)
- Database Management System Environment (ILO 3)
- Introduction to MySQL (ILO 4)
- Creating a database (ILOs 4, 5 and 6)

The assessment tasks were given in quiz form and as a practical exercise to carry out the given tasks based on the topics discussed in the tutorial. The home page and main sections of the video tutorial are illustrated in Appendix 5.5.

## 5.4 Evaluation of the KMSS prototype

This section describes the evaluation of the KMSS prototype. The pilot testing of the prototype before actual data collection, and the data collected from two samples of regular users of knowledge management software are described in this section.

### 5.4.1 Pilot testing of the KMSS prototype

This section describes the pilot testing of the KMSS prototype as well as the data collection process. The KMSS prototype was tested in several stages. Firstly, it was tested by the PhD supervisor, and by an external reviewer with expertise in evaluating the quality attributes of knowledge management software. Suggestions for improving the features of the prototype were taken into consideration in order to develop an enhanced version of KMSS prototype. Secondly, the KMSS prototype was given to two colleagues (fellow PhD students) who were asked to identify the drawbacks of the prototype and to make suggestions for further improvements. Their feedback on the features was taken into consideration before the next stage of pilot testing. Thirdly, five participants were invited to carry out the tasks as would be done for the planned data collection. The pilot testing process of the questionnaire described in Section 2.7.5 was also followed here in order to derive an improved version of the questionnaire before conducting the actual data collection.

### 5.4.2 Data collection for the evaluation of the KMSS prototype

The process of data collection outlined in Chapter 2 and the data collection protocol included in Appendix 2.1 were executed to carry out the evaluation of the quality attributes of the KMSS prototype in a constructive learning environment.

Participants were invited to voluntarily participate in the data collection sessions via e-mail and posters (given in Appendix 2.5) displayed at the School of Computing at Keele University. Data collection sessions were conducted on 14$^{th}$, 15$^{th}$ and 16$^{th}$ May, 2014. These sessions were held in a computer lab at the School of Computing and Mathematics, which was reserved by the data collection session leader several weeks in advance. Its suitability for the data collection sessions and in terms of the availability of facilities to run the components of the KMSS prototype (including a web-based video tutorial on each computer) was ensured.

Each session was held on a single day and lasted for two hours. Upon entering the lab, participants were invited to log on to a PC with their user name and password, read an information sheet (containing details about the research), and complete a consent form. An opportunity to ask questions was then offered. It was made clear that participation was voluntary, and that withdrawal from the study was possible at any time. All the necessary information on how to use the KMSS prototype was given on a printed handout. Each user was given the user name and password they needed to log on to the KMSS prototype as well as the MySQL database in order to carry out the practical exercises. The participants were clearly informed that the purpose of the questionnaire given to them was to assess the quality features of the KMSS prototype, not the features of MySQL software which was going to be used in executing the practical exercises. Upon logging on to the KMSS prototype, the activities given to the participants to carry out using KMSS prototype were to familiarise themselves with the KMSS user interface, to learn the tutorial, to carry out the assessment tasks, and to complete the questionnaire survey. The learning activities to be completed included an "Introduction to databases" video tutorial and review quizzes which required approximately 45 minutes. The evaluation activities included a quiz (15 minutes) and a practical exercise using MySQL (45 minutes).

A questionnaire (see Appendix 2.4) was included for the participants to use to rate the quality features of the KMSS prototype after using it. The questionnaire was web-based and took approximately 20 minutes to complete; all responses were automatically stored in the KMSS. The participants were given permission to submit only one questionnaire, and no one had authority to alter the details of the responses they gave in the questionnaire after submission. A total of 28 participants attended over the course of the three days (8 participants on the first day, 15 participants on the second day, and 5 participants on the third day). The results of questionnaire survey are presented in Section 5.4.3. In addition to the questionnaire survey, the academic performance over the given assessment tasks (the quiz and practical test) was considered as an additional method to reflect the effectiveness of learning through the KMSS. The results of the assessment tasks are presented in Section 5.4.4.

In order to identify the similarities and differences in the data collected based on geographical location, a similar sample was selected from undergraduate students on the Computer Science Degree programme at the University of Colombo, Sri Lanka. A data collection session was conducted using the same procedure used at the Keele University, UK. The head of the School of Computing was contacted to gain permission for data collection. A lecturer was assigned to administer the data collection session there, and a total of 30 participants took part in the data collection session. The results of the questionnaire survey are presented in Section 5.4.3

### 5.4.3 Results of the questionnaire survey

This section presents the results of the data collection achieved through the questionnaire survey. The questionnaire included questions reflecting the quality attributes identified in the SLR. The participants were asked to rate each quality attribute given in the questionnaire on a five-point scale ("Strongly Agree"-SA, "Agree"-A, "Neutral"-N, "Disagree"-D or "Strongly Disagree"-SD) to determine the perceived level of quality of the KMSS prototype. The participants' "Strongly Agree" and "Agree" choices of responses were considered as positive. Responses in the "Neutral" category were considered as neither agreeing nor disagreeing with the quality attributes of the KMSS prototype, while responses in the "Disagree" and "Strongly Disagree" categories were considered as negative responses in this analysis.

**Data Collected from questionnaire survey - Keele University, UK**

The frequency analysis of the responses received to the questionnaire survey from a sample of 28 regular users of knowledge management software from the School of Computing and Mathematics at Keele University, UK is presented in Appendix 5.7. All the questions in the questionnaire received over 75% positive responses, and for all the questions, "Neutral", “Disagree” and “Strongly Disagree” responses were less than 18%. According to the frequency analysis of the responses, it is evident that presence of all the quality attributes identified from the SLR is important for quality of any knowledge management software.

**Data Collected from questionnaire survey – the University of Colombo, Sri Lanka**

A summary of the responses to the questionnaire surveys gathered from a sample of 30 regular users of knowledge management software from the University of Colombo, Sri Lanka, is presented in Appendix 5.8. “Strongly Agree” and “Agree” responses were considered as positive responses in this analysis. The results show that the positive responses were above 70% in frequency, while “Neutral” responses were less than 23%, and negative responses were less than 10%. These responses given by regular users of knowledge management software provide evidence supporting the existence of quality attributes in the KMSS prototype.

**Comparison of the data collected from Keele University, UK and the University of Colombo, Sri Lanka**

A comparison of the data collected from the samples at Keele University, UK, and at the University of Colombo Sri Lanka is presented in Appendix 5.9. According to the summarised results in Appendix 5.9, it is clear that there are more similarities in the responses than differences. Both data sets’ positive responses frequencies were above 70%. In each case, the “Neutral” response frequencies were under 23%, negative responses were under 18%. This comparison shows that there was no significant difference between the two groups of users’ perceptions on the quality attributes of KMSS prototype based on their geographical location.

Based on the frequencies of two data sets, the average frequencies of the positive responses were then further analysed.

**Average frequencies of responses on quality attributes of KMSS prototype**

Each of the KMSS's quality attribute was evaluated through one or more questions in the questionnaire. Appendix 5.10 presents the computation of the average frequency of the responses to the questionnaire survey. In this frequency computation, the average positive frequencies of the responses for the questions related to each quality attribute were considered, with the highest average frequency being 86.31% for five of the content quality features (understandability, tutorial structure, relevance, accuracy, and academic performance), and three of the platform quality features (security, reliability and accessibility).

The lowest average frequency was 76.07%, for personalisation. The results of the data collected through the questionnaire show that all the quality attributes evaluated through the questionnaire survey are important to knowledge management software.

**Responses to open ended questions**

In order to gather data on the most preferred quality features of KMSS, to identify any other quality attributes that should be included in KMSS, and to improve the data collection session, three open ended questions were included in the questionnaire. Nine participants responded to these open ended questions, which were:

- Your most preferred three features of KMSS
- Any other features that you would like to have in KMSS
- Any other comments about your experience in using KMSS

The responses received to these three questions are given in Appendix 5.11, but they do not offer evidence on any additional attributes that the participants felt should be included in the KMSS prototype. Further, the responses provided evidence of the learners' satisfactory experiences in using the KMSS prototype.

### 5.4.4 Data collected through the evaluation of academic performance

Academic performance was evaluated using two assessment tasks. A quiz and a practical exercise were given to the participants to evaluate their achievement of the learning outcomes associated with the Introduction to Database Management content included in the KMSS prototype. A frequency analysis of the academic performance for the given assessment tasks is presented in Table 5.2. The grading structure described in Section 2.8 was considered for assigning grades to the assessment tasks. Table 5.2 shows that 41 of the 58 participants (70.69%) achieved Grade "A", while 9 out of 58 participants (15.52%) achieved Grade "B". Only 4 (6.90%) participants achieved grades "C" or "D." These results indicate the achievement of learning outcomes, and therefore the effectiveness of learning through the KMSS prototype.

| Grade | Keele University, UK (N=28) | | University of Colombo, Sri Lanka (N=30) | | Total Frequency (N=58) | % of Total Freq. |
|---|---|---|---|---|---|---|
| | Frequency | % of Frequency | Frequency | % of Frequency | | |
| A | 19 | 67.86 | 22 | 73.33 | 41 | 70.69 |
| B | 5 | 17.86 | 4 | 13.33 | 9 | 15.52 |
| C | 1 | 3.57 | 3 | 10.00 | 4 | 6.90 |
| D | 3 | 10.71 | 1 | 3.33 | 4 | 6.90 |

Table 5.2 Frequency analysis of academic performance

### 5.5 Threats to the validity and reliability of the study

The measures which were taken to ensure the validity and reliability of the study are discussed in this section. The potential threats to the validity of the study in relation to its construct validity, internal validity and external validity (Kitchenham et al., 2002, Cook et al., 1979, Shadish et al., 2002) were considered in advance of the data collection in order to ensure the validity of this study. The data collection protocol (see Appendix 2.1) was implemented having been designed after considering Per Runeson and Martin Höst's case study design checklist (Runeson et al., 2012).

#### 5.5.1 Construct validity

As suggested by Yin (Yin, 2009), the study's construct validity was strengthened through the use of multiple sources of evidence (the SLR, the evaluation of the KMSS prototype using a questionnaire survey, of academic performance through the practical test and quiz, and of a sample of KMS platforms), thus establishing a chain of evidence. A well-structured database of collected data was maintained, with the final report referring heavily to the collected evidence, the protocol procedures were followed, deviations documented, and expert reviewers were invited to review the draft protocol and reports.

#### 5.5.2 Internal validity

Internal validity relates to the genuineness of claimed casual relationships. As suggested by Yin (Yin, 2009) internal validity is of primary concern in casual case study designs. Concerns regarding internal validity should be applied to the many instances when the investigator makes inferences based on the collected data (i.e. that an observed outcome is attributable to some prior occurrence or concept). Replication with pattern matching and explanation building was therefore used to address concerns about the internal validity of the data collection methods.

### 5.5.3 External validity

External validity refers to the extent to which the findings of investigation can be generalised. The sample of participants used in this study for data collection using the questionnaire survey and academic performance evaluation (see section 5.4.3 and 5.4.4) were undergraduate students in the School of Computing and Mathematics, Keele University, UK. In order to minimise any possible threats in generalising to similar novice learners, a similar sample of learners from the University of Colombo, Sri Lanka was also included. The average frequencies of data collected from these two geographic locations were considered in the formalisation of the quality assessment framework for knowledge management software.

### 5.5.4 Reliability

The reliability of the data collection methods explained in this protocol relates to the extent to which the investigation would achieve the same results if it were repeated. Reliability was enhanced through the use of a detailed protocol and a well-structured database for the collected data. Further, because the data collection protocol underwent expert review in addition to peer review, the risk of unidentified threats to the validity of the study was considered to have been minimised.

## 5.6 Limitations of the design, implementation and evaluation of the KMSS prototype

This section discusses the limitations associated with selecting a KMS platform for designing a prototype, in the design and implementation of the KMSS prototype, and in data collection relating to the evaluation of the quality attributes of the KMSS prototype.

The main limitation in the present study associated with its selection of a KMS platform is that only 15 KMS platforms out of more than 250 available platforms were chosen for comparison. The second limitation in choosing a KMS platform relates to considering the features based on the information provided on the product websites, which may be biased or inaccurate. However, the purpose of this qualitative selection was to choose a KMS platform to use to design experimental activities that reflected the quality attributes identified in the SLR of this research. Therefore, these limitations did not affect the purpose of the comparison in this research.

There are limitations in the design and implementation of the prototype since it was mainly considered as a learning environment rather than an enterprise KMS platform. This prototype served as the test bed for data collection through a questionnaire survey. The additional components required for a university, such as such as links to its library resources, additional resources for learning, grade details, student records and career guidance, can be added to the prototype to use it as an enterprise KMS platform, a process which would be time consuming and beyond the scope of this research.

The evaluation of the quality attributes of the KMSS prototype using a small sample of participants may lead to limitations in generalising the findings. There are also limitations with regard to the chosen data collection method, one of which is the need for participants to attend a two hour session, which may have led to a low participation rate. Lastly, there are limitations associated with questionnaire surveys as a research method, as discussed in Chapter 2.

### 5.7 Summary

The design, implementation and evaluation of a KMSS prototype as described in this chapter forms the main sections of this research, which involved integrating the quality attributes of knowledge management software which were identified through the SLR. The qualitative selection of a KMS platform for the design, development and implementation of a KMSS prototype was described in this chapter.

Based on the qualitative selection of widely used KMS platforms, Microsoft Office 365 was selected as the KMS platform to use because it has many features which reflect the quality attributes identified through the SLR. A KMS software prototype was designed, developed and implemented for use as the test bed for empirical data collection in this research. A questionnaire designed to evaluate the quality attributes identified through the SLR was given to a sample of 58 regular users of knowledge management software across two geographic locations (UK and Sri Lanka). Data collection using a questionnaire survey was followed by using the KMSS prototype to carry out given teaching and learning tasks which had been designed according to the learning theories described in Chapter 4. The responses to the questionnaire revealed that all the quality attributes evaluated through the questionnaire survey were important for knowledge management software. In order to ensure the validity and reliability of this study, threats to validity and reliability and the measures taken to counter them were discussed in this chapter. Finally, the limitations of the design, implementation and evaluation of the KMSS prototype were discussed. The data collected in this stage of the research was used as the main source of empirical data for the formalisation of the quality assessment framework for the knowledge management software, which is described and discussed next, in Chapter 6.

# Chapter 6: Formalisation of the quality assessment framework for knowledge management software

## 6.1 Chapter synopsis and outline

This chapter describes the formalisation of the quality assessment framework for knowledge management software based on the results of the SLR (described in Chapter 3) and the empirical study (described in Chapter 5), which forms the main contribution of this research. The process of formalisation using a multi-element analysis technique based on software engineering evaluation methods, along with its final outcome, are presented in this chapter. The overall quality of knowledge management software is presented as a single value using the framework described in the chapter. This chapter is organised as follows:

- In Section 6.2, the process of formalisation of the quality assessment framework is described.
- In Section 6.3, the quality attributes of the quality assessment framework are discussed.
- The quality assessment framework for knowledge management software is presented in Section 6.4.
- In Section 6.5, the limitations of the formalisation of quality assessment framework are described.
- Finally, a summary of this chapter is given in Section 6.6

## 6.2 Process of formalisation of the quality assessment framework

Figure 6.1 shows the stages involved in the formalisation of the quality assessment framework. This process began with identifying the research objectives mentioned in Chapter 1. After reviewing the literature on research methods in software engineering (described in Chapter 2), an empirical approach was adopted. Data collection was then carried out using the Systematic Literature Review and the evaluation of a KMSS prototype using a questionnaire survey, as described in Chapters 3 and 5 respectively. Data collection via the questionnaire survey was followed by the evaluation of a KMSS prototype by regular users of knowledge management software, as described in Chapter 5. The empirical results collected from the questionnaire survey were presented in Section 5.4. The results of the data collected from these two methods were compared using a frequency analysis, which is presented in the next section of this chapter. The quality assessment framework presented in Section 6.4 was formalised by combining three categories of quality attributes to represent the overall quality of knowledge management software using a single value. A multi-element analysis technique, which is described below in Section 6.4, was adopted for the formalisation of the quality assessment framework. Finally, the application and evaluation of the formalised quality assessment framework is described in Chapter 7.

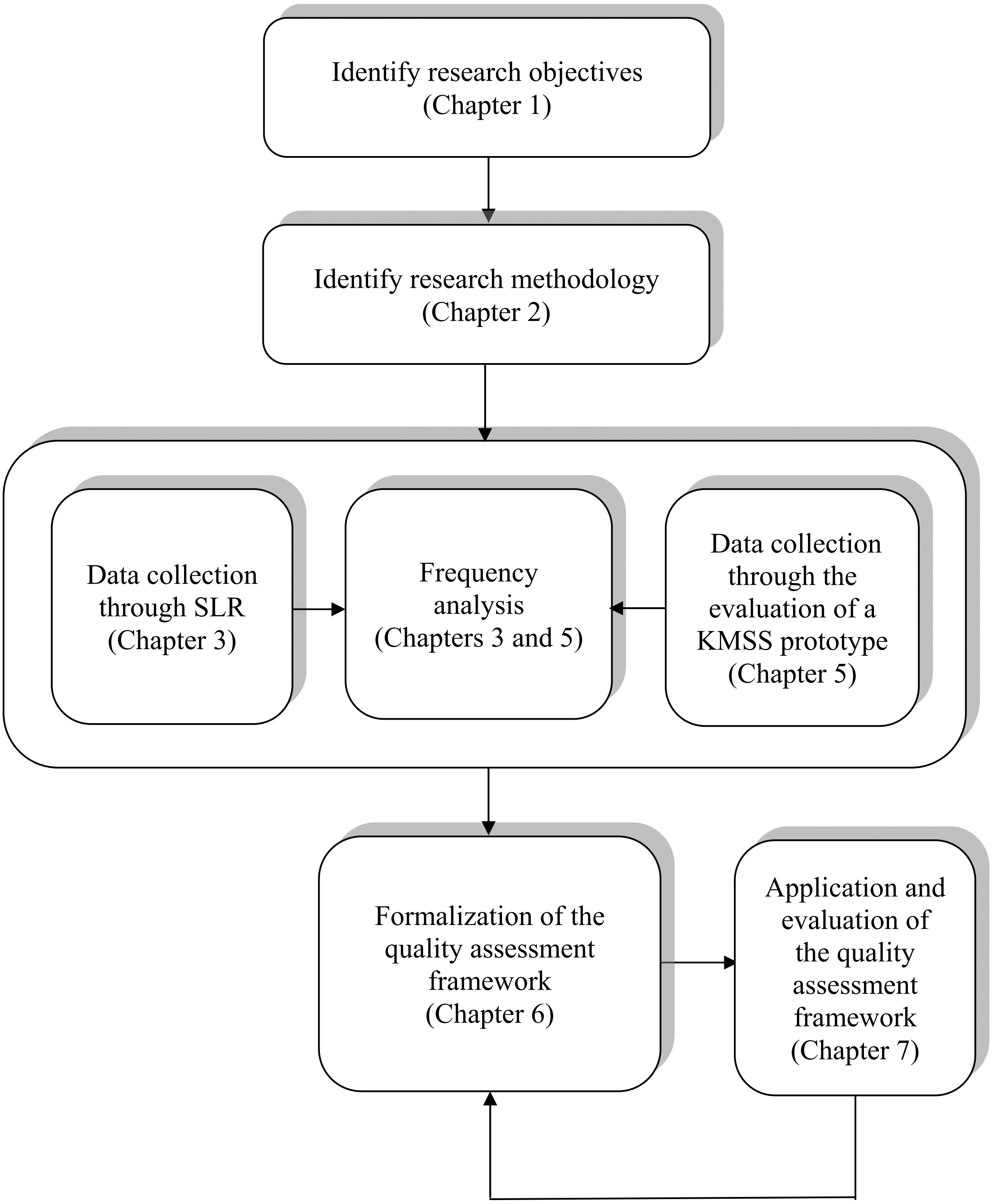


Figure 6.1 Stages in the formalisation of the quality assessment framework

### 6.2.1 Comparison of two data sets (SLR vs. evaluation of the KMSS prototype)

A comparative analysis of the data collected from the SLR and the quality evaluation of the KMSS prototype using a questionnaire survey is presented in this section. The similarities and differences between the data collected through these two methods with regard to the quality attributes of knowledge management software were considered in the formalisation of the quality assessment framework. The results of the comparison of frequency analysis of two data sets under three main categories of quality attributes (content quality, platform quality and user satisfaction, respectively) are presented in Appendix 6.1. In this comparison, the data collected through the SLR has not been categorised, but the data collected through the questionnaire was categorised into the 5-point scale from "Strongly Agree" to "Strongly Disagree". In order to compare these two data sets, only the average of the "Strongly Agree" and "Agree" responses in the questionnaire were considered. Three open ended questions were also included in the questionnaire in order to identify any quality attributes other than those assessed through questionnaire survey; however, no additional attributes were identified by the participants in their answers to these questions.

Note that the highest values in Appendix 6.1 are given the lowest ranks. When quality attributes share the same rank, all are given the same average rank and the rank of the quality attribute with the next rank is adjusted appropriately. For example, in Appendix 6.1 both "Information contextual quality" and "Easy to use" have a value of 58.33%, which is the highest value for the frequencies in the SLR. Thus, these two attributes share ranks 1 and 2, giving an average rank of 1.5, while "Content representation," which is ranked the next highest (i.e. 50.00%) is given a rank of 3 because both rank 1 and rank 2 have already been used.

The data presented in Appendix 6.1 shows some similarities as well as differences in the frequencies of the data collected by the SLR and the questionnaire survey. The two attributes attaining the highest rank in the SLR were “Information contextual quality” and “Easy to use,” while six quality attributes held the highest rank in the questionnaire survey (“understandability”, “tutorial structure”, “academic performance”, “security”, “reliability” and “interactivity”). Based on the frequencies and ranks in the two data sets, it is clear that there are more differences than similarities across the data sets.

The data collected through the SLR showed low frequencies for some of the quality attributes due to the lack of publications in the SLR on the quality assessment of knowledge management software. However, more than 77% of the responses to all the quality attributes for the data collected from the 58 respondents through questionnaire survey were positive; indicate the importance of evidencing the requirement of fulfilling all these quality attributes in knowledge management software. Therefore, the evaluation of the KMSS prototype by the questionnaire survey in this research gave more validity to the data collected through the SLR.

### 6.3 Quality attributes of the quality assessment framework

The quality attributes for the quality assessment framework were identified via an analysis of the data gathered through the SLR and the KMSS prototype evaluation using the survey. This framework has three main categories of quality attributes: content quality, platform quality and user satisfaction. There are 41 different quality attributes in this framework; 20 under content quality, 13 under platform quality, and 8 under user satisfaction. The quality attributes in the quality assessment framework for knowledge management software are presented in Figure 6.2. A brief description of each quality attribute in this framework is given in Appendix 2.3.

**Content quality**

- Content representation
- Consistency
- Flexibility
- Interactive content
- Learning model
- Clarity
- Understandability
- Tutorial structure
- Up-to-datedness
- Learner assessment quality
- Well-organized
- Completeness
- Relevancy
- Accuracy
- Teaching and learning
- Reliability
- Information contextual quality
- Self-regulated learning
- Usefulness
- Academic performance

**Platform quality**

- Easy to use
- Security
- Reliability
- Usability
- Help option available
- User friendly
- Well-organized
- Availability
- Personalization
- Interactivity
- Accessibility
- Response time
- Easy to communicate

**User satisfaction**

- Efficiency and effectiveness
- Intention to use
- Learner attitudes towards KMSS
- Enjoyable experience
- Learners' study habits
- Motivation/commitment /self esteem
- Communication with fellow learners
- Time management/time on task

Figure 6.2 Quality attributes of the quality assessment framework

### 6.4 Quality assessment framework for knowledge management software

This section describes the quality assessment framework which was formalised by combining the three categories of quality attributes presented in Figure 6.2. In this framework, the overall quality of a KMSS platform is represented as a single value using a quantitative evaluation method. A Quality Index is calculated based on the results of the SLR and the quality evaluation of the KMSS prototype using a questionnaire survey as a single quantitative measure that represents the quality of the knowledge management software. A multi-element analysis technique is adopted to build an overall Quality Index for knowledge management software (Gilb, 1977). This technique was first proposed by the mathematician Zangerneister in 1970. Since then, the method has been successfully applied as a system evaluation technique; for example, it was used by the Magnavox Electronic Systems Company (1990) in their evaluation of software development environments for Version 1 of the Advanced Field Artillery Tactical Data System (Buvaneswari et al., 1999). Three required fundamental features when applying this method are: a hierarchical organisation of quality attributes/classes, a percentage weighting determined for each these attributes, and numeric scoring for the final attributes/subclasses (Khan et al., 1997). The method depends on a hierarchical organisation of quality attributes/classes and the percentage weights for these attributes. For each attribute/class throughout the construction, a percentage weight should be determined. The final attributes/classes are also assigned numeric scores to measure their performance.

The methodology for calculating scores using this technique starts by assigning weightings to all the child nodes of each parent node in the attribute hierarchy. Then, the scores should be assigned to the leaf nodes and the assigned weightings used to propagate the quality scores to the root. Intuitively, for all the child nodes of each parent node the sum of the weightings should add up to 100 (Khan et al., 1997). The essential three components needed to apply this technique were already derived in the proposed framework. Therefore, this technique is adopted to define the measurement scheme and calculate the overall Quality Index for any given knowledge management software. Using the relative importance of the quality attributes (calculated based on the average rank from the results of the SLR and the questionnaire survey) as a parameter for measurement allows the flexibility to adopt the framework in different knowledge management software environments with different users. The importance weightings could be modified if a quality attribute appears not to hold the same significance for the quality assessment as it once did, or does in other contexts. For example, in a knowledge management software environment used for a staff training programme, if any of these 41 quality attributes is considered less important depending on the users' backgrounds in the context where the knowledge management software is to be used, the relative importance of those quality attributes can then be altered (depending on the average rank calculated based on an SLR and a survey of a sample of users). Similarly, the number of quality attributes to be considered can be reduced if any quality attribute is not as important to the selected users, and the quality index can be calculated based on the quality attributes which do need to be considered.

Three main quality factors were identified for the proposed framework, and each factor consisted of a number of quality attributes (41 in total). A relative importance weighting was assigned to each attribute inside the main category of quality attributes, and a relative importance weighting was given to each category (i.e. content quality, platform quality and user satisfaction) in the overall Quality Index. The percentages of the weightings of all attributes inside each category add up to 100%. In the same way, the accumulated percentage weighting of the three quality attributes categories is always 100%. These three categories of quality attributes and the associated metrics were mapped into a measurement scheme along with the relative importance weightings for the three categories, and the quality attributes under each category. Figure 6.3 shows the quality assessment framework and the symbols used for each parameter in the calculation of the overall Quality Index for knowledge management software.

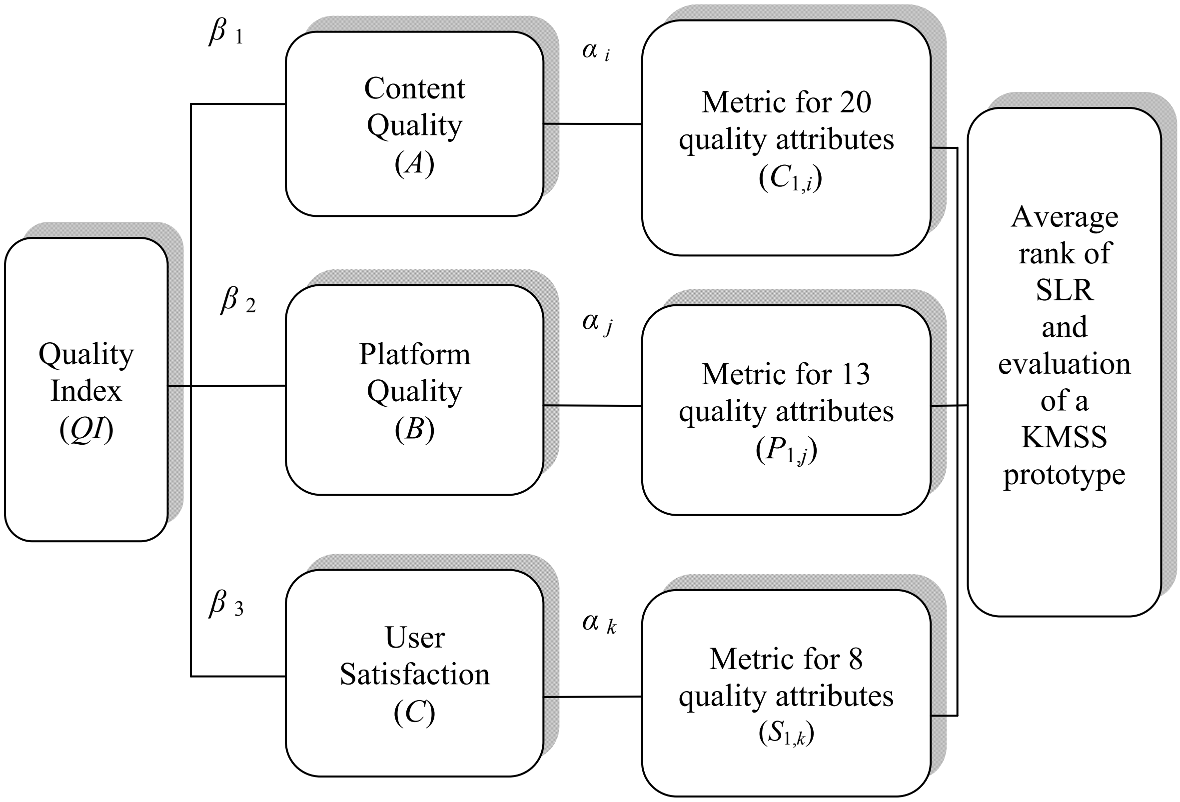


Figure 6.3 Quality assessment framework for knowledge management software

As shown in Figure 6.3 metric for each quality attribute is the average rank of SLR and evaluation of a KMSS prototype. These values represent the child node of the multi element analysis technique described above. The metrics for each quality attribute are categorised under three sub categories as content quality, platform quality and user satisfaction (quality attributes under each category are mentioned in Figure 6.2). Quality score calculated based on metrics for each quality attribute under content quality, platform quality and user satisfaction sub categories represent the parent node of the multi element analysis technique. Quality index calculated based on quality scores and weightings is the root of this framework

**Definitions of the symbols used**

- $C_{1,i}$, $P_{1,j}$, and $S_{1,k}$: Metric calculated for each quality attribute under content quality ($i$=1 to 20), platform quality ($j$=1 to 13), and user satisfaction ($k$=1 to 8) respectively
- $\alpha_i$, $\alpha_j$ and $\alpha_k$: Weighting calculated for each quality attribute within the three categories of quality attributes (i.e. content quality, platform quality, and user satisfaction) respectively
- $A$, $B$ and $C$: Quality score calculated for three categories of quality attributes (i.e. content quality, platform quality and user satisfaction) respectively
- $\beta_1$, $\beta_2$ and $\beta_3$: Weightings assigned to each category of quality attribute (i.e. content quality, platform quality and user satisfaction) respectively
- $QI$: Quality Index

Method of calculation of each term defined above is explained in the following section with worked examples.

| (i) | (ii) | (iii) | (iv) | (v) | (vi) | (vii) | (viii) | (ix) |
|---|---|---|---|---|---|---|---|---|
| | **Quality attribute** | **SLR (N=12)** | **SLR rank** | **Quest. survey (N=58)** | **Quest. survey rank** | **Avg. rank ($C_{1,i}$)** | **% Relative Avg. rank ($\alpha_i$)** | **Avg. Rank*Relative avg. rank ($\alpha_i * C_{1,i}$)** |
| 1 | Content representation | 50.00 | 3.00 | 84.58 | 11.00 | 7.00 | 1.74 | 0.12 |
| 2 | Consistency | 16.67 | 34.50 | 79.40 | 35.00 | 34.75 | 8.63 | 3.00 |
| 3 | Flexibility | 16.67 | 34.50 | 79.40 | 35.00 | 34.75 | 8.63 | 3.00 |
| 4 | Interactivity | 16.67 | 34.50 | 79.40 | 35.00 | 34.75 | 8.63 | 3.00 |
| 5 | Learning model | 16.67 | 34.50 | 80.68 | 30.00 | 32.25 | 8.01 | 2.58 |
| 6 | Clarity | 16.67 | 34.50 | 77.74 | 40.00 | 37.25 | 9.25 | 3.45 |
| 7 | Understandability | 33.33 | 16.50 | 86.31 | 3.50 | 10.00 | 2.48 | 0.25 |
| 8 | Tutorial structure | 25.00 | 24.00 | 86.31 | 3.50 | 13.75 | 3.42 | 0.47 |
| 9 | Up-to-datedness | 41.67 | 8.50 | 82.86 | 18.00 | 13.25 | 3.29 | 0.44 |
| 10 | Learner assessment quality | 25.00 | 24.00 | 80.89 | 29.00 | 26.50 | 6.58 | 1.74 |
| 11 | Well-organised | 25.00 | 24.00 | 82.86 | 18.00 | 21.00 | 5.22 | 1.10 |
| 12 | Completeness | 41.67 | 8.50 | 79.17 | 39.00 | 23.75 | 5.90 | 1.40 |
| 13 | Relevancy | 41.67 | 8.50 | 86.19 | 8.00 | 8.25 | 2.05 | 0.17 |
| 14 | Accuracy | 41.67 | 8.50 | 86.19 | 8.00 | 8.25 | 2.05 | 0.17 |
| 15 | Teaching and learning | 41.67 | 8.50 | 81.19 | 26.00 | 17.25 | 4.29 | 0.74 |
| 16 | Reliability | 41.67 | 8.50 | 85.12 | 10.00 | 9.25 | 2.30 | 0.21 |
| 17 | Information contextual quality | 58.33 | 1.50 | 80.30 | 31.00 | 16.25 | 4.04 | 0.66 |
| 18 | Self-regulated learning | 33.33 | 16.50 | 82.62 | 21.00 | 18.75 | 4.66 | 0.87 |
| 19 | Usefulness | 41.67 | 8.50 | 79.40 | 35.00 | 21.75 | 5.40 | 1.18 |
| 20 | Academic performance | 25.00 | 24.00 | 86.31 | 3.50 | 13.75 | 3.42 | 0.47 |
| | Total | | | | | 402.50 | 100.00 | 25.01 |
| | Average | | | | | 20.13 | | |

Table 6.1 Summary of calculations for content quality

| (i) | (ii) | (iii) | (iv) | (v) | (vi) | (vii) | (viii) | (ix) |
|---|---|---|---|---|---|---|---|---|
| | **Quality attribute** | **SLR (N=12)** | **SLR rank** | **Questionnaire survey (N=58)** | **Questionnaire survey rank** | **Avg. rank ($P_{1,j}$)** | **% Relative avg. rank ($\alpha_j$ )** | **Avg. rank*Relative avg. rank ($\alpha_j$*$P_{1,j}$)** |
| 21 | Easy to use | 58.33 | 1.50 | 83.15 | 14.00 | 7.75 | 3.02 | 0.23 |
| 22 | Security | 25.00 | 24.00 | 86.31 | 3.50 | 13.75 | 5.35 | 0.74 |
| 23 | Reliability | 33.33 | 16.50 | 86.31 | 3.50 | 10.00 | 3.89 | 0.39 |
| 24 | Usability | 16.67 | 34.50 | 82.26 | 23.00 | 28.75 | 11.19 | 3.22 |
| 25 | Help option available | 16.67 | 34.50 | 82.62 | 21.00 | 27.75 | 10.80 | 3.00 |
| 26 | User friendly | 16.67 | 34.50 | 82.98 | 15.50 | 25.00 | 9.73 | 2.43 |
| 27 | Well-organised | 16.67 | 34.50 | 84.40 | 13.00 | 23.75 | 9.24 | 2.19 |
| 28 | Availability | 41.67 | 8.50 | 84.52 | 12.00 | 10.25 | 3.99 | 0.41 |
| 29 | Personalisation | 16.67 | 34.50 | 76.07 | 41.00 | 37.75 | 14.69 | 5.54 |
| 30 | Interactivity | 8.33 | 41.00 | 86.31 | 3.50 | 22.25 | 8.66 | 1.93 |
| 31 | Accessibility | 33.33 | 16.50 | 86.19 | 8.00 | 12.25 | 4.77 | 0.58 |
| 32 | Response Time | 41.67 | 8.50 | 82.98 | 15.50 | 12.00 | 4.67 | 0.56 |
| 33 | Easy to communicate | 25.00 | 24.00 | 80.95 | 27.50 | 25.75 | 10.02 | 2.58 |
| | Total | | | | | 257.00 | 100.00 | 23.80 |
| | Average | | | | | 19.77 | | |

Table 6.2 Summary of calculations for platform quality

| (i) | (ii) | (iii) | (iv) | (v) | (vi) | (vii) | (viii) | (ix) |
|---|---|---|---|---|---|---|---|---|
| | **Quality attribute** | **SLR (N=12)** | **SLR rank** | **Questionnaire survey (N=58)** | **Questionnaire survey rank** | **Avg. rank ($S_{1,k}$)** | **% Relative avg. rank ($\alpha_k$)** | **% Relative avg. rank *Avg. rank ($\alpha_k$*$S_{1,k}$)** |
| 34 | Efficiency and effectiveness | 41.67 | 8.50 | 79.40 | 35.00 | 21.75 | 10.79 | 2.35 |
| 35 | Intention to use | 33.33 | 16.50 | 79.40 | 35.00 | 25.75 | 12.78 | 3.29 |
| 36 | Learner attitudes toward KMSS | 16.67 | 34.50 | 82.19 | 24.00 | 29.25 | 14.52 | 4.25 |
| 37 | Enjoyable experience | 16.67 | 34.50 | 82.86 | 18.00 | 26.25 | 13.03 | 3.42 |
| 38 | Learners' study habits | 25.00 | 24.00 | 81.55 | 25.00 | 24.50 | 12.16 | 2.98 |
| 39 | Motivation/commitment/self esteem | 25.00 | 24.00 | 82.62 | 21.00 | 22.50 | 11.17 | 2.51 |
| 40 | Communication with fellow learners | 33.33 | 16.50 | 80.95 | 27.50 | 22.00 | 10.92 | 2.40 |
| 41 | Time management/time on task | 25.00 | 24.00 | 79.40 | 35.00 | 29.50 | 14.64 | 4.32 |
| | Total | | | | | 201.50 | 100.00 | 25.52 |
| | Average | | | | | 25.19 | | |

Table 6.3 Summary of calculations for user satisfaction

**Method of calculation of the Quality Index (*QI*)**

This section explains the step by step process of calculation of the Quality Index. Worked examples illustrate the use of the formula for the calculation at each step using raw data. The calculated values for steps 1, 2 and 3 for content quality, platform quality and user satisfaction are given in Tables 6.1, 6.2 and 6.3 respectively.

**Step 1: Calculation of metric for each quality attribute ($C_{1,i}$, $P_{1,j}$ and $S_{1,k}$)**

Based on the data collected through the SLR and the evaluation of a KMSS prototype using the questionnaire survey, an average rank was calculated for each quality attribute (given in Appendix 6.1).

$C_{1,i}$: Average rank from the SLR and questionnaire survey for each content quality attribute where $i$=1 to 20

$P_{1,j}$: Average rank from the SLR and questionnaire survey for each platform quality attribute where $j$=1 to 13

$S_{1,k}$: Average rank from the SLR and questionnaire survey for each user satisfaction quality attribute where $k$=1 to 8

***Worked example for the calculation of metrics for each quality attribute ($C_{1,i}$, $P_{1,j}$ and $S_{1,k}$)***

Quality Attribute considered for this example: content representation

Rank of content representation from SLR = 3.00

Rank of content representation from questionnaire survey = 11.00

Average rank of content representation from SLR and questionnaire survey = 7.00

Therefore, metric for content representation ($C_{1,1}$) = 7.00

Calculated values of metric for each quality attribute under content quality ($C_{1,i}$), platform quality ($P_{1,j}$) and user satisfaction ($S_{1,k}$) as illustrated in the example above are shown in column (vii) in Tables 6.1, 6.2 and 6.3.

**Step 2: Calculation of weightings for quality attributes ($\alpha_i$, $\alpha_j$ and $\alpha_k$)**

The metrics calculated for each quality attribute ($C_{1,i}$, $P_{1,j}$ and $S_{1,k}$) described in step 1 were used for calculating the weightings for quality attributes ($\alpha_i$, $\alpha_j$ and $\alpha_k$). Weightings were calculated based on the relative importance of each attribute under each category of quality attribute (i.e. $\alpha_i$ was calculated for content quality attributes where $i$=1 to 20, $\alpha_j$ was calculated for platform quality attributes where $j$=1 to 13 and $\alpha_k$ was calculated for user satisfaction attributes where $k$=1 to 8). The method of calculation of $\alpha_{i,}$ $\alpha_{j,}$ and $\alpha_j$ is illustrated below.

$\alpha_i = C_{1,i}/\sum C_{1,i}$ where $i$ =1 to 20

$\alpha_j = P_{1,j} /\sum P_{1,j}$ where $j$=1 to13

$\alpha_k = S_{1,k} /\sum S_{1,k}$ where $k$=1 to 8

***Worked example for the calculation of weightings for quality attributes ($\alpha_i$, $\alpha_j$ and $\alpha_k$)***

Quality Attribute: content representation

Average rank of content representation ($C_{1,1}$) = 7.00

Sum of average rank of content quality attributes ($\sum C_{1,i}$) = 402.50

Weighting for content representation ($\alpha_1$) = $C_{1,1}/\sum C_{1,i}$ = (7.00/402.50) *100 = 1.74%

Similarly, weightings for 20 quality attributes under content quality ($\alpha_i$) are shown in column (viii) in Table 6.1. Weightings for 13 quality attributes under platform quality ($\alpha_j$) are shown in column (viii) in Table 6.2 and weightings for 8 quality attributes under user satisfaction ($\alpha_k$) are shown in column (viii) in Table 6.3 respectively.

**Step 3: Calculation of quality score for the three categories of quality attributes (*A*, *B* and *C*)**:

The quality score is the sum of the average rank multiplied by weightings for each quality attribute under content quality ($A$), platform quality ($B$) and user satisfaction ($C$).

Quality score for content quality ($A$) $=\sum \alpha_i (C_{1,i})$ where $i$ =1 to 20 (6.1)

Quality score for platform quality ($B$) $=\sum \alpha_j (P_{1,j})$ where $j$=1 to13 (6.2)

Quality score for user satisfaction ($C$) $=\sum \alpha_k (S_{1,k})$ where $k$=1 to 8 (6.3)

***Worked example for the calculation of quality scores for three categories of quality attributes (A, B and C)****:*

Based on the calculation of $(C_{1,\mathrm{i}})$ in step 1,

$(C_{1,1}) = 7.00$

Based on the calculation of $\alpha_i$ step 2,

$\alpha_1$=1.74%

$\alpha_1 * (C_{1,1}) = (1.74/100)*7.00=0.12$

Similarly, calculated values of $\alpha_i (C_{1,i})$ where $i$ = 1 to 20 are shown in column (ix) of table 6.1,

According to equation (6.1),

The quality score for content quality ($A$) = $\sum \alpha_i (C_{1,i})$ where $i$ = 1 to 20

$A =\sum \alpha_i (C_{1,i}) = 25.01$; this is the sum of values in column (ix) in Table 6.1

As explained above, the calculation of the quality score for platform quality ($B$) $=\sum \alpha_j (P_{1,j})$ where $j$=1 to13 based on equation (6.2) is shown in column (ix) in Table 6.2.

$B =\sum \alpha_j (P_{1,j})= 23.80$

Similarly, the calculation of the quality score for user satisfaction ($C$) $=\sum \alpha_k (S_{1,k})$ where $k$=1 to 8 based on equation (6.3) is shown in column (ix) in Table 6.3.

$C =\sum \alpha_k (S_{1,k})= 25.52$

**Step 4: Calculation of weightings for three categories of quality attributes ($\beta_1$, $\beta_2$ and $\beta_3$)**

$\beta_1$, $\beta_2$ and $\beta_3$ represent the relative importance of the three categories for the overall quality of KMSS. The average ranks of content quality, platform quality and user satisfaction are ($w_1$) 20.13%, ($w_2$)19.77%, and ($w_3$)25.19% respectively (these values are shown as average values in column (vii) in Tables 6.1, 6.2 and 6.3 respectively). Considering these average ranks, the relative importance weighting of each category of quality attribute was calculated as follows:

Weighting for content quality ($\beta_1$) = $[w_1/ (w_1+ w_2+ w_3)]$ 100 (6.4)

Weighting for platform quality ($\beta_2$) = $[w_2/ (w_1+ w_2+ w_3)]$ 100 (6.5)

Weighting for user satisfaction ($\beta_3$) = $[w_3/ (w_1+ w_2+ w_3)]$100 (6.6)

***Worked example for the calculation of weightings for the three categories of quality attributes ($\beta_1$, $\beta_2$ and $\beta_3$)***

According to the calculation of rank shown in column (vii) of Table 6.1, the average rank of content quality ($w_1$) = 20.13%

Similarly, the average rank of platform quality ($w_2$) = 19.77%, as shown in column (vii) of Table 6.2, and the average rank of user satisfaction ($w_3$) = 25.19%, as shown in column (vii) of Table 6.3.

According to equation (6.4),

The weighting for content quality ($\beta_1$) = [20.13/ (20.13+19.77+25.19)] 100=30.92%

According to equation (6.5),

The weighting for platform quality ($\beta_2$) = [19.77/ (20.13+19.77+25.19)] 100=30.38%

According to equation (6.6),

The weighting for user satisfaction ($\beta_3$) = [25.19/(20.13+19.77+25.19)] 100=38.70%

**Step 5: Calculation of quality factors for three categories of quality attributes ($QF_1$, $QF_2$ and $QF_3$)**

For each category of quality attributes, a quality factor was calculated using the weightings and quality scores computed in the previous stages.

Quality factor for content quality ($QF_1$) = $\beta_1 A$ (6.7)

Quality factor for platform quality ($QF_2$) = $\beta_2 B$ (6.8)

Quality factor for user satisfaction ($QF_3$) = $\beta_3 C$ (6.9)

***Worked example for the calculation of quality factors for the three categories of quality attributes ($QF_1$, $QF_2$ and $QF_3$)***

Based on the calculation in step 3, $\beta_1$ = 30.92%

Based on the calculation in step 4, $A = \sum \alpha_i \, (C_{1,i})$ = 25.01

According to equation (6.7), the quality factor for content quality($QF_1$) = $\beta_1 A$

$QF_1$ = (30.92/100)*25.01=7.74%

Similarly, $\beta_2$=30.38% and $B$ =23.80

According to equation (6.8), the quality factor for platform quality ($QF_2$) = $\beta_2 B$

$QF_2$ = (30.38/100)* 23.80=7.23%

$\beta_3$=38.70% and $C$=25.52

According to equation (6.9), the quality factor for content quality ($QF_3$) = $\beta_3 C$

$QF_3$ = (38.70/100)* 25.52=9.88%

**Step 6: Calculation of the Quality Index (*QI*)**

Using the quality factors computed in the previous stage, and the total number of quality attributes in the quality assessment framework, the overall Quality Index was then calculated. The value of the overall Quality Index is intended for consideration when making decisions on the quality of specific knowledge management software systems.

*QI* = [(Sum of the Quality Factors for content quality, platform quality and user satisfaction/number of quality attributes)]100

$$QI = [(QF_1+QF_2+QF_3/ n)]100 = [(\beta_1 A + \beta_2 B + \beta_3 C)/n]100 \quad (6.10)$$

Where $n=i+j+k$

***Worked example for the calculation of the Quality Index (QI)***

According to the calculation of the quality factors described in step 5, $QF_1$ = 7.74%, $QF_2$ = 7.23% and $QF_3$ = 9.88% respectively.

Based on equation (6.10), the Quality Index *(QI)* = $[(QF_1+QF_2+QF_3/ n)]100$, where $n=i+j+k$

$n$=20+13+8=41

$QI$ =(7.74+7.23+9.88/41)*100

$QI$ =61.00%

A summary of the calculation of the Quality Index for the KMSS prototype using each of the steps described above is presented in Table 6.4. Equations used for each step of the calculation and the relevant worked example for calculation of the Quality Index are summarised.

| Parameter and relevant equation | Relevant worked example | Category of quality attribute | | | Total |
|---|---|---|---|---|---|
| | | Content quality | Platform quality | User satisfaction | |
| Quality score ($A$, $B$ and $C$) (equations 6.1, 6.2 and 6. 3) | Step 3 | 25.01% | 23.80% | 25.52% | 74.33% |
| Weighting ($\beta_1$ , $\beta_2$ and $\beta_3$) (equations 6.4, 6.5 and 6.6) | Step 4 | 30.92% | 30.38% | 38.70% | 100.00% |
| Quality Factor ($QF_1$, $QF_2$ and $QF_3$) (equations 6.7, 6.8 and 6.9) | Step 5 | 7.74% | 7.23% | 9.88% | 24.84% |
| Number of quality attributes ($i$, $j$ and $k$) | | 20.00 | 13.00 | 8.00 | 41.00 |
| Quality Index ($QI$) (equation 6.10) | Step 6 | | | | 61.00% |

Table 6.4 Calculation of the Quality Index for the KMSS prototype

According to the calculation of the Quality Index shown in Table 6.4, the overall Quality Index for the KMSS prototype developed in this research is 61.00%. The average rank of 41 quality attributes based on the SLR and survey responses are sorted into content quality, platform quality and user satisfaction categories was considered in the calculation of this Quality Index. This value of the Quality Index represents the average quality of the KMSS prototype as assessed by the users of the KMSS prototype and the results of the SLR. The above method of calculation of Quality Index can be used to evaluate the quality of a given knowledge management software as well as to compare a range of knowledge management software.

### 6.5 Limitations of the formalisation of the quality assessment framework

This section describes the limitations of the process of formalising the quality assessment framework as well as the final outcome itself: the quality assessment framework for knowledge management software. This framework was formalised based on the SLR and the empirical data collected through the questionnaire survey. One of the main limitations in the questionnaire survey was the use of a convenience sample (a sample of undergraduate students from Keele University, UK and the University of Colombo, Sri Lanka) of regular users of knowledge management software. This limitation can be minimised by selecting a random sample of regular users of knowledge management software from different backgrounds in addition to undergraduate students. The second limitation is that due to using a questionnaire survey, data collection was limited to focusing only on the quality attributes identified through the SLR. Three open ended questions were included to minimise this problem in the questionnaire. Using qualitative data collection methods such as interviewing and case studies is potentially useful in identifying the additional quality features expected by stakeholders of knowledge management software. Thirdly, in devising this framework, learning effectiveness was considered as the primary requirement for managing knowledge in relation to knowledge management software since learning is one of the core processes of knowledge management software. The third limitation mentioned above can be minimised by extending this framework to other core processes of knowledge management software such as knowledge creation, storage and dissemination.

In this framework, the overall quality of the KMSS prototype was evaluated by calculating a Quality Index, as discussed in the previous sub-sections of this chapter. The ranking of the frequencies of quality attributes based on the data gathered from SLR and the questionnaire survey were used in these calculations. The average frequencies computed based on analysing the data gathered from the SLR and questionnaire survey were used in the calculation of the overall quality score. Due to the low frequencies in the SLR for the evidence relating to the quality attributes in the literature, there was a significant difference between the data collected from the questionnaires and from the SLR. In the ranking of quality attributes, the highest frequencies were given the lowest rankings. Therefore, in interpreting the quality of knowledge management software, a lower value in the Quality Index represents higher quality. This limitation can be minimised by considering the reciprocal value of the Quality Index when comparing a range of KMS platforms using the Quality Index described in this framework.

## 6.6 Summary

In this chapter, a quality assessment framework offering potential benefits to decision makers in selecting suitable knowledge management software based on quality attributes has been presented. The basis of this framework was the SLR and an empirical study carried out for the evaluation of the quality attributes of the KMSS prototype. A frequency analysis of the data collected from these two main sources was applied in the formalisation of the framework, which has three main categories of quality attributes: platform quality, content quality, and user satisfaction. A multi-element analysis technique was adopted in the framework in order to build an overall Quality Index for knowledge management software, which was formalised by integrating 41 quality attributes consisting of 20 content quality attributes, 13 platform quality attributes, and 8 user satisfaction quality attributes. The value of this newly-created Quality Index is that one can decide which knowledge management software suits best and satisfy specific quality requirements. The quality assessment of knowledge management software using this framework is flexible and can easily be modified by changing the number of quality attributes and weightings which need to be considered. The application and evaluation of the quality assessment framework is described in Chapter 7.

# Chapter 7: Application and evaluation of the quality assessment framework for knowledge management software

## 7.1 Chapter synopsis and outline

This chapter describes the application and evaluation of the formalised quality assessment framework for knowledge management software (described in Chapter 6). The application and evaluation described in this chapter aimed to validate and evaluate the quality assessment framework. In this evaluation, the quality assessment framework was applied to a range of KMS platforms by a sample of evaluators, who evaluated the framework for its understandability and user satisfaction using a questionnaire survey. In this chapter, the method and results of the application and evaluation of the quality assessment framework are presented. Objective seven of the research, mentioned in Chapter 1, was achieved through the process described in this chapter.

This chapter is organised as follows:

- The application of the quality assessment framework for knowledge management software is described in Section 7.2
- The results of the application of the quality assessment framework for knowledge management software are presented in Section 7.3
- In Section 7.4, the evaluation of the quality assessment framework for knowledge management software is described.
- The limitations of the application and evaluation of the quality assessment framework are described in Sections 7.5.

- A summary of the chapter is given in Section 7.6.

### 7.2 Application of the quality assessment framework

The quality assessment framework formalised in chapter 6 was applied to a range of KMS platforms. In order to ensure unbiased objective evaluation, a sample of eight evaluators was selected to carry out this evaluation. The criterion for the evaluation of a KMS platform was the Quality Index (QI), which was formalised based on the relative importance of each quality attribute as described in Section 6.4 in Chapter 6. The Quality Index score is presented as a percentage and used as the decision criteria for determining the quality of a KMS platform. Depending on the value of the Quality Index, the quality level of a KMS platform can be determined. An organisation or an individual deciding whether to accept or reject a KMS platform based on its quality attributes can use this framework, which is based on the overall Quality Index which integrates a total of 41 quality attributes.

Any KMS platform could be considered for evaluation. In this research, six widely used commercial and open source KMS platforms were selected; each evaluator was given these six KMS platforms to evaluate, and the same KMS platforms were given to all the evaluators. This evaluation is independent of the module or subject content considered in the evaluation. For ease of comparative evaluation, when six platforms were evaluated by one evaluator, an Information Technology module (e.g. Database Management) in each of these platforms was considered. The following six KMS platforms were considered in this evaluation.

- Platform 1 (P1): Office 365-KMSS prototype

  URL: https://KMSSkeele.sharepoint.com/teams/KMSS

- Platform 2 (P2): W3School

URL: http://www.w3schools.com/sql/

- Platform 3 (P3): BlackBoard-Keele University

  URL: http://students.keele.ac.uk/webapps/portal/frameset.jsp?tab_tab_group_id=_2_1

- Platform 4 (P4): OpenedX-Stanford University

  URL: http://online.stanford.edu/course/intro-to-databases-winter-2014

- Platform 5 (P5): OpenCourseware-Massachusetts Institute of Technology (MIT)

  URL: http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-830-database-systems-fall-2010/

- Platform 6 (P6): OpenLearn-Open University UK

  URL: http://www.open.edu/openlearn/science-maths-technology

The KMS platforms listed above were evaluated by eight regular users of KMS software for teaching and learning (undergraduate and postgraduate students). These evaluators were invited to voluntarily participate in the evaluation, and were sent information on its method by e-mail along with their consent to participate in this evaluation was sought. Each evaluator was given the URLs of selected 6 KMS platforms and the questionnaire (given in Appendix 2.4) which they were asked to use to rate the quality attributes of the platforms. The participants' responses to the questionnaire were gathered, and a frequency analysis was conducted. "Strongly Agree" and "Agree" responses were considered as positive responses, and the average of these two categories of responses were considered in this evaluation.

## 7.3 Results of the application of the quality assessment framework

The data gathered from this evaluation is summarised in Appendix 7.1. The computation of the overall Quality Index explained using steps 1 to 6, as described in Section 6.4 in Chapter 6, was used for the evaluation of overall quality of each KMS platform. The calculation of the Quality Index for six KMS platforms (P1 to P6 mentioned in Section 7.2) using equations 1 to 10, again described in section 6.4 in Chapter 6, is presented here in Tables 7.1 to 7.6.

| **Parameter and relevant equation** | **Content quality** | **Platform quality** | **User satisfaction** | **Total** |
|---|---|---|---|---|
| Average Rank (SLR & Ques.) | 20.94% | 20.85% | 21.41% | 63.20% |
| Quality Score (*A*, *B* and *C*) (equations 6.1, 6.2 and 6. 3) | 24.86% | 23.57% | 23.85% | 72.28% |
| Weighting ($\beta_1$, $\beta_2$ and $\beta_3$) (equations 6.4, 6.5 and 6.6) | 33.13% | 32.99% | 33.88% | 100.00% |
| Quality Factor ($QF_1$, $QF_2$ and $QF_3$) (equations 6.7, 6.8 and 6.9) | 8.24% | 7.78% | 8.08% | 24.09% |
| Number of quality attributes (*i*, *j* and *k*) | 20.00 | 13.00 | 8.00 | 41.00 |
| Quality Index (*QI*) (equation 6.10) | | | | 58.76% |

Table 7.1 Calculation of Quality Index for P1: Office 365-KMSS prototype

| **Parameter and relevant equation** | **Content quality** | **Platform quality** | **User satisfaction** | **Total** |
|---|---|---|---|---|
| Average Rank (SLR & Ques.) | 18.84% | 21.15% | 26.16% | 66.15% |
| Quality Score (*A*, *B* and *C*) (equations 6.1, 6.2 and 6. 3) | 21.92% | 25.18% | 26.97% | 74.07% |
| Weighting ($\beta_1$, $\beta_2$ and $\beta_3$) (equations 6.4, 6.5 and 6.6) | 28.48% | 31.97% | 39.55% | 100.00% |
| Quality Factor ($QF_1$, $QF_2$ and $QF_3$) (equations 6.7, 6.8 and 6.9) | 6.24% | 8.05% | 10.67% | 24.96% |
| Number of quality attributes (*i*, *j* and *k*) | 20.00 | 13.00 | 8.00 | 41.00 |
| Quality Index (*QI*) (equation 6.10) | | | | 60.88% |

Table 7.2 Calculation of Quality Index for P2: W3School

| **Parameter and relevant equation** | **Content Quality** | **Platform Quality** | **User Satisfaction** | **Total** |
|---|---|---|---|---|
| Average Rank (SLR & Ques.) | 22.24% | 20.71% | 18.38% | 61.33% |
| Quality Score (*A*, *B* and *C*) (equations 6.1, 6.2 and 6. 3) | 26.25% | 25.80% | 19.74% | 71.79% |
| Weighting ($\beta_1$, $\beta_2$ and $\beta_3$) (equations 6.4, 6.5 and 6.6) | 36.26% | 33.77% | 29.97% | 100.00% |
| Quality Factor ($QF_1$, $QF_2$ and $QF_3$) (equations 6.7, 6.8 and 6.9) | 9.52% | 8.71% | 5.92% | 24.15% |
| Number of quality attributes (*i*, *j* and *k*) | 20.00 | 13.00 | 8.00 | 41.00 |
| Quality Index (*QI*) (equation 6.10) | | | | 58.90% |

Table 7.3 Calculation of Quality Index for P3: BlackBoard-Keele University

| **Parameter and relevant equation** | **Content quality** | **Platform quality** | **User satisfaction** | **Total** |
|---|---|---|---|---|
| Average Rank (SLR & Ques.) | 18.08% | 22.33% | 26.16% | 66.57% |
| Quality Score (*A*, *B* and *C*) (equations 6.1, 6.2 and 6. 3) | 21.79% | 25.59% | 27.67% | 75.05% |
| Weighting ($\beta_1$, $\beta_2$ and $\beta_3$) (equations 6.4, 6.5 and 6.6) | 27.16% | 33.54% | 39.30% | 100.00% |
| Quality Factor ($QF_1$, $QF_2$ and $QF_3$) (equations 6.7, 6.8 and 6.9) | 5.92% | 8.58% | 10.87% | 25.38% |
| Number of quality attributes (*i*, *j* and *k*) | 20 | 13 | 8 | 41 |
| Quality Index (*QI*) (equation 6.10) | | | | 61.89% |

Table 7.4 Calculation of Quality Index for P4: OpenedX-Stanford University

| **Parameter and relevant equation** | **Content quality** | **Platform quality** | **User satisfaction** | **Total** |
|---|---|---|---|---|
| Average Rank (SLR & Ques.) | 21.34% | 21.48% | 19.38% | 62.20% |
| Quality Score (*A*, *B* and *C*) (equations 6.1, 6.2 and 6. 3) | 25.47% | 26.18% | 20.36% | 72.01% |
| Weighting ($\beta_1$, $\beta_2$ and $\beta_3$) (equations 6.4, 6.5 and 6.6) | 34.31% | 34.53% | 31.16% | 100.00% |
| Quality Factor ($QF_1$, $QF_2$ and $QF_3$) (equations 6.7, 6.8 and 6.9) | 8.74% | 9.04% | 6.34% | 24.12% |
| Number of quality attributes (*i*, *j* and *k*) | 20.00 | 13.00 | 8.00 | 41.00 |
| Quality Index (*QI*) (equation 6.10) | | | | 58.84% |

Table 7.5 Calculation of Quality Index for P5: OpenCourseware-MIT

| Parameter and relevant equation | Content quality | Platform quality | User satisfaction | Total |
|---|---|---|---|---|
| Average Rank (SLR & Ques.) | 19.26% | 23.67% | 21.00% | 63.93% |
| Quality score ($A$, $B$ and $C$) (equations 6.1, 6.2 and 6. 3) | 22.99% | 26.13% | 23.41% | 72.53% |
| Weighting ($\beta_1$, $\beta_2$ and $\beta_3$) (equations 6.4, 6.5 and 6.6) | 30.13% | 37.02% | 32.85% | 100.00% |
| Quality Factor ($QF_1$, $QF_2$ and $QF_3$) (equations 6.7, 6.8 and 6.9) | 6.93% | 9.67% | 7.69% | 24.29% |
| Number of quality attributes ($i$, $j$ and $k$) | 20.00 | 13.00 | 8.00 | 41.00 |
| Quality Index ($QI$) (equation 6.10) | | | | 59.25% |

Table 7.6 Calculation of Quality Index for P6: OpenLearn-Open University UK

Since there are differences and similarities among the data collected through the SLR and the questionnaire survey, the average ranks of frequencies emerging from the SLR and the questionnaire survey were considered in this evaluation. If any quality attributes had the same rank, the average value of ranks for all the quality attributes at the same rank was assigned and the next rank was adjusted accordingly. The lowest rank was given to the highest frequency score for both the SLR and the questionnaire survey results. Therefore, the lowest value in the Quality Index represents the KMS platform with the highest perceived quality. The overall Quality Index of the six platforms is given in Table 7.7.

| KMS platform | Quality Index (%) |
|---|---|
| P1: Office 365-KMSS prototype | 58.76 |
| P2: OpenCourseware-MIT | 58.84 |
| P3: BlackBoard-Keele University | 58.90 |
| P4: OpenLearn-Open University UK | 59.25 |
| P5: W3School | 60.88 |
| P6: Open edX-Stanford University | 61.89 |

Table 7.7 Quality Index of six KMS platforms

The results presented in Table 7.7 show that the P1: KMSS prototype developed using Microsoft Office 365 in this research achieved the lowest Quality Index score among the six platforms considered in this evaluation, with 58.76%, indicating that the KMSS prototype was of the highest quality compared to the other platforms in the comparison. All the other platforms considered in this evaluation showed higher Quality Index values, as can be seen in Table 7.7. Therefore, it is proved that the quality attributes in this framework are essential for learning effectiveness in knowledge management software. Furthermore, the KMSS prototype had the highest average frequency of responses for all three categories of quality attributes among the six platforms in the evaluation (based on the summarised data given in Appendix 7.1). The frequencies calculated from the SLR data had low values due to the lack of publications in the literature which reported on quality attributes. Therefore, the data collected from the evaluation of the KMSS prototype through the questionnaire survey had more significance for the calculated Quality Index values. The quality assessment framework formalised in this research was validated through the application of the framework described in this section.

### 7.4 Evaluation of the quality assessment framework

When using any quality assessment framework, it should be easily understandable and users should be satisfied with the process and the results of their evaluation. In this evaluation, understandability and user satisfaction were the criteria for the evaluation of the framework in gathering users' perceptions of the process and the results of the quality assessment of knowledge management software using the Quality Index to evaluate the quality of different knowledge management software. The data was gathered through a questionnaire survey from a sample of regular users of knowledge management software who applied the framework (described in the previous section) in responding.

### 7.4.1 Evaluation criteria

**Understandability**

The objective here was to analyse how easily the users could understand and use the quality assessment framework in order to evaluate the quality of knowledge management software.

**User satisfaction**

The objective was to analyse the level of user satisfaction with the process and results of the quality assessment framework.

Through these two criteria, the effectiveness and quality of the quality assessment framework were evaluated, and any areas with deficiencies were identified to further improve the framework. The evaluation of the end product is important in order to highlight areas where deficiencies exist.

### 7.4.2 Method of evaluation

Questionnaires have been identified as an effective method for evaluation of the quality of an end product in software engineering. In this evaluation a questionnaire survey was used to evaluate the quality assessment framework, followed by the application of the quality assessment framework to evaluate the quality features of KMS platforms described in section 7.2. After using the quality assessment framework to evaluate the quality attributes of the KMS platforms, the evaluators were given a questionnaire (included in Appendix 7.2) to evaluate the quality assessment framework along with information for that evaluation (given in Appendix 7.3). This method of evaluation was considered appropriate since the results gathered would reflect the real-life application of the framework by regular users of KMS software. The questionnaire included three sections consisting of 5 questions for the evaluation of understandability (Section A), 7 questions for the evaluation of the user satisfaction of the framework (Section B) and 3 questions to gather additional comments on the usability of the framework.

### 7.4.3 Results of the evaluation

The summarised responses with regard to the evaluation of the quality assessment framework are presented in Tables 7.8, 7.9 and 7.10, for sections A, B and C of the questionnaire respectively. In this evaluation, "Strongly Agree" and "Agree" responses were considered to be positive responses. As was mentioned above, five questions were given in the questionnaire to evaluate the understandability of the framework. Table 7.8 presents the data collected from the users of the framework on the understandability of the framework.

| **Section A: Understandability** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Strongly Agree** | | **Agree** | | **Neutral** | | **Disagree** | | **Strongly Disagree** | |
| | **Frequency** | **%** | **Frequency** | **%** | **Frequency** | **%** | **Frequency** | **%** | **Frequency** | **%** |
| 1. Quality assessment framework for knowledge management software representation is very clear | 7 | 87.5 | 1 | 12.5 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 2. It is easy to understand the definitions of quality attributes under three main categories of quality, e.g. content quality, platform quality and user satisfaction | 6 | 75.0 | 2 | 25.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 3. Quality evaluation method using quality assessment framework for knowledge management software is easy to understand and unambiguous | 6 | 75.0 | 2 | 25.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 4. No special knowledge or training on software evaluation is needed to use the quality assessment framework for knowledge management software | 8 | 100.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 5. It is easy to use the quality assessment framework for knowledge management software | 7 | 87.5 | 1 | 12.5 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |

Table 7.8 Summary of responses to section A of the questionnaire

The results of this evaluation show that "Strongly Agree" and "Agree" categories of responses to the questions on understandability totalled more than 75% of all answers. Less than 12.5% of responses were in the "Neutral", "Disagree and "Strongly Disagree" categories in response to the questions in section A of the questionnaire.

Section B of the questionnaire included 7 questions evaluating the user satisfaction of the framework. The responses to Section B of the questionnaire are presented in Table 7.9.

| **Section B: User Satisfaction** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Strongly Agree** | | **Agree** | | **Neutral** | | **Disagree** | | **Strongly Disagree** | |
| | **Frequency** | **%** | **Frequency** | **%** | **Frequency** | **%** | **Frequency** | **%** | **Frequency** | **%** |
| 6. Quality assessment framework for knowledge management software can be applied to any knowledge management software to evaluate its quality | 6 | 75.0 | 1 | 12.5 | 1 | 12.5 | 0 | 0.0 | 0 | 0.0 |
| 7. Using the quality assessment framework for knowledge management software, level of quality of knowledge management software can be evaluated | 7 | 87.5 | 1 | 12.5 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 8. Quality assessment framework for knowledge management software can be used for making decision on selecting most appropriate knowledge management software based on its quality attributes | 5 | 62.5 | 1 | 12.5 | 1 | 12.5 | 1 | 12.5 | 0 | 0.0 |
| 9. Quality assessment framework for knowledge management software is self-contained | 7 | 87.5 | 1 | 12.5 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 10. The assessment method of the quality assessment framework for knowledge management software is useful | 6 | 75.0 | 1 | 12.5 | 1 | 12.5 | 0 | 0.0 | 0 | 0.0 |
| 11. Quality assessment framework for knowledge management software is a useful tool for evaluating quality of knowledge management software | 8 | 100.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| 12. It is important to implement quality assessment framework for knowledge management software in the form of an automated software tool in order to facilitate evaluating quality of knowledge management software | 8 | 100.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |

Table 7.9 Summary of responses to section B of the questionnaire

The results of this evaluation show that the “Strongly Agree” and “Agree” categories of responses to the questions regarding user satisfaction with the framework formed more than

75% of all responses. Less than 12.5% of responses to the questions in section B of the questionnaire were “Neutral”, “Disagree” or “Strongly Disagree.”

The responses to Section C of the questionnaire are summarised in Table 7.10. There were three responses to questions on additional quality attributes which should be included in the framework, however the quality attributes mentioned by the respondents were in fact already included in the framework (e.g. one of the respondent mentioned “Link to social media” as an additional quality attribute for inclusion; this attribute is evaluated through the “Communication with fellow learners” quality attribute in the framework).

Users’ responses to the request for suggestions for further improving the framework were: including other factors such as cost and scalability (1 response), developing a software tool (6 responses), giving reasons for the decision (4 responses), and the ability to select quality attributes for evaluation (3 responses). These responses will be considered in further improving this framework in the future.

| **Section C: Additional comments** |
|---|
| 13. Are there any quality attributes that you may suggest to add to the framework?<br>*Response 1: Interactivity of Help (2 responses)*<br>*Response 2: Quality of Interface (2 responses)*<br>*Response 3: Link to Social media (3 responses)* |
| 14. Please provide your comments relating to the assessment method used in this framework<br>*Response 1: Easy to understand and comprehensive method (2 responses)*<br>*Response 2: Using a spread sheet to calculate is useful (3 responses)* |
| 15.Your suggestions to further improve quality assessment framework<br>*Response 1: Include other factors such as cost and scalability (1 response)* |

| |
|---|
| *Response 2: Developing a software tool (6 responses)*<br>*Response 3: Reason for decision (4 responses)*<br>*Response 4: Ability to select quality attributes for evaluation (3 responses)* |

Table 7.10 Summary of responses to Section C of the questionnaire

This method of evaluation is easy for any evaluator to undertake without any special prior knowledge or experience. The evaluation is purely based on the experimental results gathered from actual users of knowledge management software. According to the feedback gathered from the evaluators, the quality assessment framework for knowledge management software is practical and effective.

**7.5 Limitations of the application and evaluation of the quality assessment framework**

This section describes the limitations of the process and results of the application and evaluation of the framework. The overall quality of a range of KMS platforms was evaluated by calculating a Quality Index, with rankings of frequencies of quality attributes based on the data gathered from the SLR and the evaluation of KMS platforms through a questionnaire survey. The average frequencies computed from the SLR data and the evaluation of the KMS platforms were then used in the calculation of an overall quality score. Due to the low frequencies in the SLR for the evidence relating to quality attributes in the literature, a significant difference is evident between the data collected from the questionnaire survey and that which was gathered by the SLR. For this evaluation, the KMS platforms which were open access to the evaluators were selected due to restrictions on obtaining permission to access the KMS platforms used in organisations. A sample of eight regular users of KMS software (undergraduate and postgraduate students) was selected as evaluators. For a more rigorous evaluation, the same procedure could be applied for a larger number of KMS platforms using a larger sample of evaluators. Furthermore, in addition to the evaluation of the framework by the regular users of KMS software described in this chapter, another evaluation method such as expert review could also add more validity to the framework.

### 7.6 Summary

In this chapter, the application and evaluation of the quality assessment framework have been presented. In the quality assessment framework, a multi-element analysis technique was adopted to produce an overall Quality Index for a KMS platform. The results of the application of the quality assessment framework for a range of KMS platforms showed that the highest overall quality among the six platforms was to be found in the KMSS prototype designed for this study. Taking the value of the Quality Index into consideration, an individual or organisation can decide which KMS platform suits them best, and is most likely to satisfy their quality requirements. It is clear that this method of evaluation is very easy to use by any evaluator and no special skills or technical knowledge are needed. The evaluation method is also flexible, and can easily be modified by changing the number of quality attributes which need to be considered in an evaluation. For a comprehensive evaluation, the same set of KMS platforms under evaluation should be given to the same sample of evaluators and any differences in their evaluations should be taken into consideration for the final evaluation.

This framework as a method of quality evaluation of knowledge management was purely based on the results of the SLR and users' perceptions. Therefore, this evaluation has more validity than the qualitative evaluation of KMS platforms (based on information given on product websites for commercial purposes by the vendors of KMS platforms), as described in Section 5.2 in Chapter 5, which discussed the initial selection of a KMS platform for this research. The quality assessment framework was validated through this application of the framework.

In addition to the application of quality assessment framework to evaluate a range of KMS platforms, the evaluation of the quality assessment framework itself by frequent users of knowledge management software was also described in this chapter. Understandability and user satisfaction were the criteria for the evaluation of the framework. The quality assessment framework was evaluated using a questionnaire survey followed by the application of the framework by a sample of evaluators. The evaluation proved the effectiveness and practicality of the quality assessment framework in assessing the quality of a KMS platform.

Finally, the limitations of the chosen evaluation method were identified. These limitations can be avoided by using a larger sample of evaluators, and a larger number of KMS platforms. Furthermore, developing a software tool for this framework will minimise the time needed for the application of the framework. Like any other model and framework, this quality assessment framework is also a dynamic framework that can be extended and evolved based on the results of the application of the evaluation method described in the present chapter. The results of this evaluation will be considered in refining the quality assessment framework in future research. The use of an additional method of evaluation of the framework, such as expert review, is suggested as a possible direction for future work.

# Chapter 8: Supplementary literature review

## 8.1 Chapter synopsis and outline

The original Systematic Literature Review (SLR) for this research was conducted in 2011, and therefore it covered publications up to and including 2011. To ensure if there is any relevant research published up to the time of submitting this thesis has missed in this research, a supplementary literature review has taken place which searched for publications from January 2012 to July 2016. This chapter describes the results in relation to the research questions in the SLR (described in Chapter 3) by considering the relevant publications identified by the supplementary review from January 2012 to July 2016.

This chapter is organised as follows:

- Section 8.2 describes the results in relation to the research questions in the SLR
- A discussion of the findings is described in section 8.3
- A summary of this chapter is given in section 8.4

## 8.2 Results in relation to the research questions in the SLR

The search strategy mentioned in Chapter 3 was implemented once again for this supplementary literature review for the duration from January 2012 to July 2016. Additional sources of publications retrieved through Google Scholar (IEEE, Emerald Insight, Taylor and Francis, Wiley online library and ERIC) were accessed in addition to the sources mentioned in the SLR described in Chapter 3. Research questions 1 to 5, as set out in Chapter 3, were again considered in this new literature review. In order to obtain the answers to the research questions, the methodology described in the SLR protocol in Appendix 3.1 was re-adopted.

The following section gives the answers to research questions 1 to 5 emerging from this new review.

**RQ1: Which topics have been investigated by researchers working on Knowledge Management Systems (KMS) or e-Learning Systems?**

The study process described in Chapter 3 was adopted for the mapping of publications from the period January 2012 to July 2016. The categories already used for the mapping study conducted at the initial stage of this research were also used in this new categorisation. The publications selected for this supplementary mapping study (given in Appendix 8.1) were grouped into the 11 categories identified in stage (ii) of the mapping study described in section 3.3.3 in Chapter 3. Based on the title, abstract and keywords, the main focus of the publication in each case was identified, and publications which could be categorised into more than one category were considered only under the most relevant category. Table 8.1 shows the categorisation of the 84 publications retrieved which were dated from January 2012 to July 2016 in order to answer to the RQ1 of this supplementary literature review.

| Category | Properties | Publications | Total |
|---|---|---|---|
| 1. Guidelines for design and implementation | Massive E-Learning (MOOC) Design, delivery and assessment, knowledge sharing and knowledge management system avoidance, the development and use of a web-based KMS, | [1-8] | 8 (9.6%) |
| 2. Conceptual framework | Knowledge maturing model, a conceptual model of LO and KM, investigating continuance intentions towards E-Learning 2.0, the effects of individual differences on e-Learning users, a trust evaluation model for e-Learning systems, global social knowledge management-barrier framework, effect of knowledge management strategies, a service-based framework , TAM3-based model, an extension of the technology acceptance model for e-Learning, | [9-19] | 11 (13.3%) |

| | | | |
|---|---|---|---|
| | share knowledge in online communities of practice, the relationship between Intellectual Capital and Knowledge Management | | |
| 3. Quality aspects | The effects of distributed leadership in the quality management of online learning environments (OLEs), the effects of quality antecedents on e-learning acceptance, sharing instructors' experiences of learning management systems | [20-30] | 11 (13.3%) |
| 4. Theoretical background | The effect of knowledge sharing visibility on incentive-based relationship in electronic Knowledge Management Systems, social influence and Knowledge Management Systems use, Data, information, knowledge, wisdom (DIKW): a semiotic theoretical and empirical exploration of the hierarchy and its quality dimension, factors influencing the use of learning management system | [31-38] | 8 (9.6%) |
| 5. Ontology based applications | Importance of the knowledge representation mechanisms | [39] | 1 (1.2%) |
| 6. Architectural model | Integrating a systems approach with learning theory in developing high-quality online courses, learning management systems and cloud file hosting services | [40, 41] | 2 (2.4%) |
| 7. Evaluation | Adapting the Technology Acceptance Model to evaluate the innovative potential of e-Learning systems, sources of satisfaction and dissatisfaction, differences in learning experience from the learner's perspective, relations between motivation, tool use, participation, and performance, easy ways to evaluate LMSs, the role of IT infrastructure services in terms of the success of e-Learning systems, measuring e-Learning systems' success, instructional use and the technology acceptation of learning management systems, critical success factors for knowledge management, behavioural intention formation in knowledge sharing, factors affecting knowledge management success, critical success | [42-52] | 11 (13.3%) |

| | | | |
|---|---|---|---|
| | factors for e-Learning in developing countries | | |
| 8. Case study | Knowledge management among nurses, university instructors' adoption of web-based learning systems, incremental development & revolutions of e-Learning software systems in the education sector, the strategic alignment and misalignment of Knowledge Management Systems | [53-56] | 4 (4.8%) |
| 9. Technology or tool | Social media's impact on organisational knowledge quality, Personal Knowledge Management (PKM), incorporating data mining tools for KM, incorporating distinct learners' profiles, using 2.0 tools, E-Learning using cloud computing, using the Facebook group as a learning management system, social software for knowledge management, context-aware recommender systems for learning, the use of the Moodle e-Learning Platform, the Web 2.0 annotation system as a learning tool | [57-72] | 16 (19.3%) |
| 10. Literature survey | A bibliometric study of the major trends in knowledge management research, critical success factors for the continuation of e-Learning initiatives, knowledge management and measurement: a critical review, a review of the approaches to knowledge management system studies, the global ranking of knowledge management and intellectual capital academic journals, information systems success: the quest for independent variables | [73-78] | 6 (7.2%) |
| 11. Assessing learning effectiveness | Collaboration factors and the quality of learning experience on interactive mobile assisted social e-Learning, organisational learning effectiveness | [79-83] | 5 (6.0%) |
| Total | | | 83 (100.0%) |

Table 8.1 Categorisation of publications for RQ1

The publications reviewed were categorised into the existing 11 categories, and properties not reported under the existing categories were also identified. The publications in the guidelines and implementation category (8 publications) examined massive E-Learning (MOOC) design, delivery and assessment, knowledge sharing and knowledge management system avoidance, and the development and use of a web-based KMS. New publications under the conceptual framework category (11 publications) were related to a knowledge maturing model, a conceptual model of Learning Objects and KM, investigating continuance intentions towards E-Learning 2.0, the effects of individual differences on e-Learning users, a trust evaluation model for E-Learning systems, global social knowledge management-barriers, the effect of knowledge management strategies, a service-based framework, the TAM3-based model, an extension of the technology acceptance model for e-Learning, sharing knowledge in online communities of practice, and the relationship between Intellectual Capital and Knowledge Management.

In all, 11 publications under the quality aspects category investigated the effects of distributed leadership in the quality management of online learning environments (OLEs), the effects of quality antecedents on e-learning acceptance, and sharing instructors' experience of learning management systems.

The publications on the theoretical background of KM (8 publications) had examined the effect of knowledge sharing visibility on incentive-based relationship in electronic Knowledge Management Systems, social influence and Knowledge Management Systems use, the factors influencing the use of learning management system, and a semiotic theoretical and empirical exploration of the hierarchy of data, information, knowledge, wisdom (DIKW) and its quality dimensions.

One publication was located on ontology-based applications which focused on the importance of knowledge representation mechanisms. Under the architectural models category, two publications were found, which concerned integrating a systems approach with learning theory for developing high-quality online courses, and learning management systems and cloud file hosting services respectively.

The publications falling within the evaluation category (11 publications) mainly focused on adapting the Technology Acceptance Model to evaluate the innovative potential of e-Learning systems, sources of satisfaction and dissatisfaction, differences in learning experience from the learner's perspective, the relations between motivation, tool use, participation, and performance, the easy ways to evaluate LMSs, the role of IT infrastructure services in terms of the success of e-Learning systems, measuring e-Learning systems' success, instructional use and the technology acceptation of learning management systems, the critical success factors for knowledge management, behavioural intention formation in knowledge sharing, the factors affecting knowledge management success, and the critical success factors for e-Learning in developing countries.

In this mapping study, four publications came under the case study category. The main focuses of these publications were on learning organisations in the service of knowledge management among nurses, university instructors' adoption of web-based learning systems, the incremental development and revolutions of e-Learning software systems in education sector, and the strategic alignment and misalignment of Knowledge Management Systems.

The publications categorised under technology or tool (16 publications) related to social media's impact on organisational knowledge quality, Personal Knowledge Management (PKM), incorporating data mining tools for KM, incorporating distinct learners' profiles, using 2.0 tools, E-Learning using cloud computing, using the Facebook group as a learning management system, social software for knowledge management, context-aware recommender systems for learning, and the use of the Moodle e-Learning Platform, and the Web 2.0 annotation system as a learning tool. It was evident that these publications were mainly focused on additional sub-categories in addition to the already identified sub-categories described under results to RQ1 in Chapter3.

Four publications were categorised as literature reviews, and the main focus of these publications were a bibliometric study on the major trends in knowledge management research, the critical success factors for the continuation of e-Learning initiatives, a critical review of knowledge management and measurement, a review of approaches to knowledge management system studies, the global ranking of knowledge management and intellectual capital academic journals, and information systems success: the quest for the independent variables.

Publications categorised as assessing learning effectiveness (5 publications) were mainly concerned with collaboration factors, the quality of learning experience on interactive mobile assisted social e-Learning and organisational learning effectiveness.

| Category | Publications up to December 2011 | Publications from January 2012 - July 2016 | Percentage increase/decrease in number of publications |
|---|---|---|---|
| 1. Guidelines for design and implementation | 56 (32.0%) | 8 (9.5%) | -22.50% |
| 2. Conceptual framework | 6 (3.4%) | 12 (14.3%) | 10.90% |
| 3. Quality aspects | 4 (2.3%) | 11 (13.1%) | 10.80% |
| 4. Theoretical background | 2 (1.1%) | 8 (9.5%) | 8.40% |
| 5. Ontology based applications | 9 (5.1%) | 1 (1.2%) | -3.90% |
| 6. Architectural model | 32 (18.3%) | 2 (2.4%) | -15.90% |
| 7. Evaluation | 13 (7.4%) | 12 (14.3%) | 6.90% |
| 8. Case study | 12 (6.9%) | 4 (4.8%) | -2.10% |
| 9. Technology or tool | 32 (18.3%) | 16 (19.0%) | 0.70% |
| 10. Literature survey | 0 (0.0%) | 6 (7.1%) | 7.10% |
| 11. Assessing learning effectiveness | 9 (5.1%) | 5 (5.9%) | 0.80% |
| Total | 175(100.0%) | 83 (100%) | |

Table 8.2 Comparison of the number of publications found from before and after 2011

Table 8.2 gives a comparison of the research studies published before the end of 2011, and those published between 2012 and July 2016. According to the summarised data in Table 8.2, the highest number of publications was in the technology or tool category, and there was no significant increase in the number of publications after January 2012 up to July 2016. There was, however, a significant increase in the number of literature reviews published in the later time period. The present supplementary literature review has given an overview of trends in the publications related to this research, particularly in category 3 (quality aspects), category 7 (evaluation) and category 11 (assessing learning effectiveness). According to the data shown in Table 8.2, more research has been published on quality aspects and evaluation categories than in the previous mapping study (up to the end of year 2011). However, there was no significant increase in the number of publications on evaluating the learning effectiveness of knowledge management software. This again justifies the need for further research on the quality aspects of the KMS and e-Learning environments, particularly by considering learning effectiveness in knowledge management software.

**RQ2: What does quality mean in relation to KMS or e-Learning Systems?**

In many publications found in this supplementary literature review, the aspects which are to be considered in assessing the quality of KMS or e-Learning systems are reported without clearly defining the quality of KMS or e-Learning. Aspects of quality that are discussed in a sample of publications retrieved for the duration from January 2012 to July 2016 are described in this section. The factors to be considered in assessing the quality of e-Learning identified as constructive alignment of pedagogy, technology and learning resources is emphasised in a study on quality of e- learning (Masoumi and Lindström, 2012). Similarly importance of three quality dimensions that emerge from the interaction of instructors, students, and IT in the context of e-Learning: system quality (which measures the technical factors of the e-Learning system and is assessed by the ease of use, functionality, and reliability of the e-Learning system), information quality (which measures the semantic factors of the e-Learning system and is assessed by the practicality, credibility, and relevance of course documents and content), and instructional quality (which measures the human factors of the e-Learning system and is assessed by the availability, responsiveness, and mastery of the subject matter by instructors) is proposed in an empirical study on impact of Content Management System (CMS) quality on the outcomes of e-Learning systems in higher education (Kim et al., 2012).

Another aspect considered in assessing quality in e-Learning systems is considered as ‘perceived system quality’ in a study on the role of perceived system quality as educators’ motivation to continue e-Learning system use (Islam, 2012). According to this study, perceived system quality is defined as the users’ evaluation of an information system from the technical and design perspectives. The of perceived system quality in terms of a web-based system such as KMS or e-Learning are access convenience, flexibility, integration, response time, sophistication, reliability, accessibility, stability, system speed, usability, ease of use, navigation and network speed (Lee et al., 2009). Similarly in a study on e-Learning acceptance, information quality, service quality, system quality, and instructor quality are considered as the antecedents for the acceptance of e-Learning (Cheng, 2012).

User satisfaction is a parameter of quality of a KMS or e-Learning system. In a study on sharing instructors experience of learning management system results indicates that the service quality, perceived usefulness, system quality and information quality have significant effect on user satisfaction in e-Learning systems (Almarashdeh, 2016).

KMS quality dimensions by investigating the related work on quality of software, data, information and knowledge systems is reported in (Jabar and Alnatsha, 2014). In this study enhancing the KMS quality through enhancing its processes quality is emphasised.

According to the results reported above based on the publications from January 2012 to July 2016 found no new publications examining definitions of quality in KMS or e-Learning. Therefore, this supplementary literature review gives evidence on the strong need for defining the quality of KMS or e-Learning systems in future research.

**RQ3: What are the quality attributes of KMS or e-Learning software?**

In all, 15 publications were retrieved in this supplementary literature review which aimed to identify the quality attributes reported in recent publications. The quality attributes reported in each publication are summarised in Table 8.3.

| Quality attributes | Publications |
|---|---|
| Information quality, system quality, perceived usefulness, service quality | (Almarashdeh, 2016) |
| Accessibility, ability to search for project-related knowledge, ability to add useful project related knowledge | (Chen et al., 2012) |
| Service quality | (Wong and Huang, 2015) |
| Attitude toward using technology, perceived ease of use and perceived usefulness | (Stantchev et al., 2014) |
| Perceived usefulness and perceived ease of use | (Islam, 2013) |
| System quality, information quality, instructional quality, user satisfaction, and CMS benefits | (Kim et al., 2012) |
| Information quality, service quality, system quality, and instructor quality | (Cheng, 2012) |
| Institutional factors, technological factors instructional design factors, pedagogical factors, evaluation factors, student support, faculty support | (Masoumi and Lindström, 2012) |
| Ease of use, perceived usefulness, social norms, quality of work life, computer self-efficacy and facilitating conditions | (Shi et al., 2013) |

| | |
|---|---|
| System quality, information quality, user-satisfaction self-regulated learning | (Saba, 2012) |
| 5 collaboration factors that affect the quality of the learning environment:<br><br>Individual accountability, group processing, social skills, prompts feedback, and perceived ability | (Wang, 2014a) |
| Personal innovativeness, perceived interaction | (Agudo-Peregrina et al., 2014) |
| Perceived usefulness and attitude, perceived ease of use, information quality and social influence, system quality | (Wu and Zhang, 2014) |
| Software quality dimensions, data, quality dimensions, information quality dimensions and knowledge systems quality dimensions | (Jabar and Alnatsha, 2014) |
| Usefulness and ease-of-use | (Persico et al., 2014) |

Table 8.3 Quality attributes of KMS or e-Learning software

According to the findings summarised in the Table 8.3, the 41 quality attributes considered in formalising the quality assessment framework in this research already included most of the quality attributes mentioned by the other research in the area which are related to the aim of this research.

**RQ4: What are the methods of assessing quality in KMS or e-Learning software?**

The methods of assessing quality suggested in various studies were reviewed based on 13 publications. The following section provides an overview of the methods used for assessing quality reported by these publications.

In a study on understanding the effects of knowledge management strategies on knowledge management performance, the data for empirical examination were obtained through a survey conducted in Korea from a sample of 154 firms (Kim et al., 2014). In another study, the findings of senior leadership interviews in a nationally-funded project on distributed leadership in the context of quality management of online learning environments (OLEs) in higher education was described (Holt et al., 2014). In that study, the questions were framed around the development of an OLE quality management framework and the characteristics of distributed leadership at the core of the framework.

Data collection using a questionnaire survey of higher education instructors was reported in a study (Almarashdeh, 2016) on "Sharing instructors experience of learning management system: A technology perspective of user satisfaction in distance learning course." Through this survey, the needs of the instructors as well as the students were identified by adopting the latest technologies. Furthermore, the negative effects of building LMS without taking instructors' satisfaction into account in terms of distance learning course outcomes were also reported.

In another recent study, a research approach based on the Technology Acceptance Model (TAM) was described in order to investigate the motivations that lead higher education students to replace several Learning Management Systems (LMS) services with cloud file hosting services for information sharing and collaboration (Stantchev et al., 2014). A model to identify the barriers and enablers to the acceptance of these technologies was developed using a questionnaire survey comprising three factors (attitude toward using technology, perceived ease of use, and perceived usefulness), which was applied to a sample of 121 higher education students. The results showed that the perceived ease of use of cloud file hosting services was above that of LMS tools and services, and that cloud file hosting services presented higher levels of perceived usefulness than standard learning management tools. In addition, attitudes toward using cloud file hosting services were found to be well above those with respect to using LMS tools.

Islam (2013) investigated the outcomes of e-Learning systems' adoption and use by conceptualising three e-Learning systems adoption outcome constructs, namely: perceived learning assistance, perceived community building assistance, and perceived academic performance. Utilising these constructs, their paper proposed a research model which could be used to assess the possible outcomes of e-Learning systems' adoption and use. They collected longitudinal survey data from 249 university students participating in hybrid courses using a popular learning management system, Moodle. A partial least squares (PLS) analytical approach was then used to test the research model. The findings suggest that beliefs about perceived usefulness, perceived ease of use, and how an e-Learning system is used influence students' perceived learning assistance and perceived community building assistance. In turn, perceived learning assistance and perceived community building assistance influence the students' perceived academic performance (Islam, 2013).

Course Management Systems (CMSs) in higher education have emerged as one of the most widely adopted e-Learning platforms. A study used a survey method to examine the success of e-Learning CMSs based on user satisfaction and benefits (Kim et al., 2012). Using DeLone and McLean's information system success model as a theoretical framework, the success of e-Learning CMSs in five dimensions (system quality, information quality, instructional quality, user satisfaction, and CMS benefits) was analysed, and the survey data collected from students participating in a university-wide CMS showed that system quality, information quality, and instructional quality positively influence user satisfaction, which, in turn, increases the benefits of CMSs. By providing a comprehensive framework for the critical success factors in e-Learning CMSs and their causal relationships, this study provided practical implications for managing e-Learning courses and resources in order to create a more flexible and effective CMS-centered, e-Learning environment.

A recent study (Li et al., 2014) incorporated a new multiple criteria decision making (MCDM) method combining quality function deployment (QFD) with a technique for order preference by similarity to an ideal solution (TOPSIS) in an intuitionistic fuzzy environment.

Another study used an evaluation model based on user trust cloud and user capability for trusted e-Learning (Tan et al., 2014).

A dynamic content sequencing system (DCSS), with empirical outcomes interpreted using Csikszentmihalyi's flow theory (i.e. Flow, Boredom, and Anxiety) was described by Katuk et al. In (Katuk et al., 2013). In this evaluation, a total of 80 participants carried out a one-way between-subject study controlled by the type of e-Learning system involved (i.e., the DCSS vs. the non-DCSS).

Overall, when surveying publications from 2012 to 2016, it is evident that the most common method of assessing quality was the survey; further, the different surveys and sample sizes used in the evaluations varied from 30 to 3500 participants.

**RQ5: How is learning effectiveness measured in KMS or e-Learning systems?**

Based on the five publications retrieved, the methods used in evaluating learning effectiveness were reviewed. A brief overview of the methods reported in each publication is given below.

One recent study used a self-evaluation survey containing 50 closed-ended items with two open ended questions applied to a sample of 50 students in order to assess the collaboration factors factors and quality of learning experience on interactive mobile assisted social e-Learning (Wang, 2014a). An analysis of this survey's results revealed that individual accountability significantly predicted the quality of the teamwork learning experience in an interactive mobile assisted social e-Learning module, as did social skills, quality of feedback, and perceived ability.

Another study developed an assessment-centered e-Learning system for improving student learning effectiveness (Wang, 2014b). This research has used web-based two-tier diagnostic assessment and web-based dynamic assessment to develop an assessment-centered e-

Learning system, which the authors named the ‘GPAM-WATA e-Learning system’. This system consists of two major designs: personalised dynamic assessment (in which the system automatically generates dynamic assessment for each learner based on the results of the pre-test of the two-tier diagnostic assessment) and personalised e-Learning material adaptive annotation (where the system annotates the e-Learning materials each learner needs) in order to enhance learning. The sample consisted of 107 sixth-graders from four classes being taught the ‘Speed’ unit on an elementary school Mathematics course (55 male and 52 female). Assessment of the learning through the e-Learning systems was used as the method for evaluating learning effectiveness in this research.

A study on pragmatic e-Learning systems design with learning investigated the differences in learning experience from the learner’s perspectives when using an adaptive e-Learning system, where the learner’s knowledge or skill level is used to configure the learning path experience (Katuk et al., 2013). Central to this study was the evaluation of a dynamic content sequencing system (DCSS), with empirical outcomes interpreted using Csikszentmihalyi’s flow theory (i.e., Flow, Boredom, and Anxiety). A total of 80 participants carried out a one-way between-subject study controlled by the type of e-Learning system used (i.e., the DCSS vs. the non-DCSS). The results indicated that the lower or medium achievers gained certain benefits from the DCSS, whilst the high achievers in learning performance were identified as potentially suffering from boredom when using the DCSS. These contrasting findings can be seen as a pragmatic design guideline for developing more engaging computer-based learning systems for unsupervised learning situations.(Katuk et al., 2013)

Another study explored how the satisfaction of employees in using e-Learning technology influenced organisational learning effectiveness (Capece and Campisi, 2013). It measured the level of satisfaction in using an e-Learning platform in a multinational company operating in the energy sector. A sample of 5395 employees participating in two on-line courses was used in this survey, in which the participants were given a questionnaire to respond to at the end of their learning activities on the basis of a Technology Acceptance Model. According to the results of the survey, the usage of e-Learning technology plays a full mediating role in the relationship between e-Learning system service and the measured level of employee satisfaction (organisational effectiveness in implementing knowledge improvement). Furthermore, it was shown by this study that well conducted e-Learning programmes can effectively be adopted by a large amount of companies: more the users are satisfied with the e-Learning service, the better in enhancing organisational learning (Capece and Campisi, 2013).

A questionnaire survey of 674 uses of an e-Learning system examined the relationships among e-Learning systems, self-efficacy, and students' apparent learning results for university online courses (Saba, 2012). The responses of students completing at least one online course run by Wawasan Open University (WOU) Malaysia were used in this study, and the results indicated that system quality, information quality, and computer self-efficacy all affected system use, user satisfaction, and the self-managed learning behaviour of students. The proposed path analytical model suggests that hypothesised variables are useful in forecasting the effectiveness of an e-Learning environment.

The findings in relation to RQ5 based on the five identified research studies published from January 2012 to July 2016 were that surveys of users of knowledge management systems and evaluating learning achievement were the most common methods of assessing learning effectiveness.

### 8.3 Discussion of the supplementary literature review

Through this supplementary literature review, answers to the same research questions as those initially used for the SLR described in Chapter 3 were obtained. In order to answer RQ1, 83 publications during the period from January 2012 to July 2016 were reviewed. According to the findings pertaining to RQ1 (as summarised in Tables 8.1 and 8.2), it is evident that the highest number of publications was in category 9: technology or tool, and that no significant increase had occurred in the number of publication in this category during the later period compared to the number before January 2012. A decrease in the number of publications for category 1: guidelines for design and implementation (22.50%) were observed. Similarly, there was a significant decrease in the number of publications in category 6: architectural model (15.90%). There was also a increase in number of publications in category 10: literature review (7.1%). Furthermore, there was also a positive trend in publications on categories related to this research, i.e. category 3: quality aspects (10.8%), category 7: evaluation (6.9%) and category 11: assessing earning effectiveness (0.8%).

In many publications retrieved for RQ2 aspects or factors of quality in KMS or e-Learning systems have been discussed without clearly defining quality of KMS or e-Learning systems. Therefore, no publications were found during this recent period which could answer RQ2.

In order to find an answer to RQ3, 15 publications during this period were reviewed. According to the quality attributes summarised in Table 8.3, it is clear that the quality assessment framework in this research has already considered all the quality attributes related to the aim of this research.

In order to answer RQ4, the methods used in 13 publications were reviewed, and survey was found to be the most common method of assessing quality.

Finally, an answer to RQ5 was achieved by reviewing 5 publications. In the publications reviewed, surveying users on their experiences in using the knowledge management systems, and assessing the achievement of learning outcomes were reported as the most commonly used methods of evaluating learning effectiveness.

### 8.4 Summary

This supplementary literature review was conducted in order to include the relevant publications which appeared after the original SLR conducted for this research. Therefore, publications from January 2012 to July 2016 were reviewed. The findings will be useful for focusing future research on the quality assessment of knowledge management software. This supplementary literature review was conducted based on publications retrieved from IEEE, Emerald Insight, Taylor and Francis, Wiley online library and ERIC in addition to the sources accessed for the previous SLR of this research. Therefore, the publications reviewed for this supplementary literature review represent a sample of publications during this period due to the time available for the review. It is therefore suggested that some additional sources of publications to be searched in future to further improve understanding of research in these areas.

# Chapter 9: Conclusion and future work

## 9.1 Chapter synopsis and outline

The preceding eight chapters of this thesis have traced the evolution of the "Quality assessment framework for knowledge management software" through the planning, design and implementation of a novel and innovative approach. This concluding chapter summarises the key contributions made to the body of knowledge in this subject field, discusses the limitations of this research, and provides an overview of potential areas for future research. The process and results of each stage of formalisation of the quality assessment framework are revisited, and a brief description of how each step was completed is provided. The major contributions of this research are presented illustrating both the applied and academic contributions arising from this research. This chapter reflects on the research methodology both in terms of its success and how it might be deployed in future research. Finally, to aid the sustainability and continuity of this research, possible future research directions and some ongoing activities and reflections on this research are described.

This chapter is organised as follows:

- In Section 8.2 a summary of the research is presented.
- In Section 8.3 a summary of the formalisation of the quality assessment framework is presented.
- The key contributions to knowledge are discussed in Section 8.4.
- In Section 8.5, the summary and limitations of the research methodology are presented.
- In Section 8.6, proposed directions for future work are described.

- Finally, in Section 8.7, some reflections on the research are provided.

### 9.2 Summary of the research

The overall aim of this research was to formalise a quality assessment framework for knowledge management software. This aim was achieved through the adoption of a novel and innovative approach. Seven objectives, which were mentioned in Section 1.3 of Chapter 1, were identified in order to achieve the aim of this research. The foundation for this research was laid after the initial mapping study identified a lack of prior research on the quality assessment of KMS. The research methodology was identified after reviewing the literature on software engineering research methodologies; an empirical approach was adopted. This research involved all the stages of a software engineering research project including designing, implementing and evaluating a KMSS prototype.

The initial literature review provided evidence that learning is the core function of managing knowledge, and that learning theories provide the foundation for designing a suitable learning environment for knowledge management software. In this research, the main learning theories were reviewed in order to choose one as the basis for enhancing the quality of knowledge management software through ensuring effective learning. A prototype KMSS was designed, implemented and quality tested based on the principles of learning and the findings of the SLR. The quality assessment framework for knowledge management software was systematically formalised based on the findings of the SLR and the experimental results. A Quality Index was then formalised based on a multi-element analysis technique, and used as a method with which to evaluate and compare KMS software packages based on their quality attributes. The understandability and user satisfaction of this framework was evaluated by asking a sample of regular users of KMS platforms to apply the quality assessment framework to a range of KMS platforms. Based on the results of that evaluation, the final outcome of this research, i.e. the quality assessment framework for knowledge management software, was formalised. The SLR of this research included publications up to the end of year 2011. Therefore, a supplementary literature review was conducted to retrieve a sample of publications from January 2012 to July 2016 in order to ensure that publications after the initial SLR were considered for this research. Results to the research questions set out in Chapter 3 for the duration from January 2012 to July 2016 is described in Chapter 8.

### 9.3 Summary of the formalisation of the quality assessment framework

The formalisation of the quality assessment framework involved the series of stages shown in Figure 6.3 in Chapter 6. This section summarises the design, development, application and evaluation of the quality assessment framework in relation to the results and deliverables at each stage of the formalisation of the quality assessment framework.

The quality attributes of the framework were initially identified through the SLR. The outcome of research question 3 (RQ3: What are the quality attributes of KMS software?) of the SLR was used as one of the main sources of data in the formalisation of the quality assessment framework. By analysing the publications retrieved for RQ3 of SLR, 41 quality attributes were categorised into content quality (20 quality attributes), platform quality (13 quality attributes) and user satisfaction (8 quality attributes).

In addition to the data gathered through the SLR, the evaluation of the KMSS prototype by regular users of knowledge management software was used as a main source of empirical data in the formalisation of the framework. The purpose of collecting data through an evaluation of the quality attributes of the KMSS prototype was to generate more validity for the data collected through the SLR in this research. In order to collect empirical data, a test bed was designed, developed and implemented in the form of a KMSS prototype which implemented the quality attributes identified through the SLR. This prototype was designed using a commercial KMS platform (Office 365) chosen based on a qualitative selection process in which 47 features of 15 widely-used commercial and open source KMS platforms were compared (see section 5.2 of Chapter 5).

Knowledge is gained through learning, and learning is crucial in managing knowledge. Through the literature review, learning effectiveness was identified as a key parameter in the quality of knowledge management software. The theories of learning reviewed in Chapter 4 of the thesis were applied in designing a KMSS prototype. A sample of 58 participants was selected from regular users of knowledge management software in two geographic locations: 28 participants from the UK (Keele University, UK), and 30 participants from Sri Lanka (University of Colombo, Sri Lanka). A questionnaire survey on the quality attributes of knowledge management software was administered to them, followed by asking them to use the KMSS prototype to undertake given learning activities. The empirical data gathered through evaluating the KMSS prototype provided more validity to the data which was previously gathered through the SLR.

Similarities as well as differences were evident between the data collected through the SLR and the empirical data collected through the questionnaire survey used in the evaluation of the KMSS prototype. A frequency analysis of the data gathered through the SLR and the questionnaire survey was used in calculating the metric for each quality attribute falling within three sub-categories (content quality, platform quality and user satisfaction). Using a multi-element analysis technique, a single value Quality Index score was produced to express the quality of knowledge management software as a further step to formalising this quality assessment framework.

Ranks of frequencies of data collected from the SLR and the evaluation of KMSS prototype were used in formalising the Quality Index. Based on the average rank of frequencies, the quality metric for each quality attribute was calculated. By considering the relative importance of each category of quality attribute, a quality score for each category of quality attribute was calculated. Weightings for each category of quality attribute were calculated by considering all three categories of quality attributes as having similar importance.

Finally, the Quality Index was formulated using weightings and quality scores for each category of quality attributes (content quality, platform quality and user satisfaction). Using the process of calculating Quality Index described above, the Quality Index for KMSS prototype was calculated and a step-by-step process with a formula used at each stage was described in section 6.4 of Chapter 6.

The understandability and user satisfaction of this framework were evaluated in two stages. Firstly, the quality assessment framework was applied to a sample of KMS platforms by a sample of regular users of KMS platforms. A sample of six widely-used KMS platforms and a sample of eight regular users of knowledge management software were selected for this application and evaluation of the framework. Details of the evaluation were given to the evaluators with links to the KMS platforms considered for this evaluation. The same questionnaire used for evaluating the quality attributes of the KMSS prototype was also used in this evaluation. The Quality Index of each KMS platform was calculated based on the data collected through the questionnaire survey and the SLR. Based on the results, the KMSS prototype was found to have the highest Quality Index score among the six platforms considered in the evaluation. The application of the quality assessment framework therefore validated it.

The formalised quality assessment framework was then evaluated through a questionnaire survey. The same sample of users of knowledge management software who had applied the quality assessment framework described above was given a questionnaire with which to assess the quality assessment framework. The criteria for this evaluation were the understandability and user satisfaction of the framework. The results proved the practicality and usefulness of the quality assessment framework for selecting a KMS platform based on its quality attributes. Furthermore, this evaluation provided valuable insights into possible ways to make further improvements, as suggestions for developing this framework as a software tool and including features to select the number of quality attributes for evaluation and to provide the reason for the final selection of the platform based on this quality evaluation were received, and will be considered for further improving this quality assessment framework in the future.

According to the findings of the supplementary literature review described in Chapter 8, it was evident that (from the results to the RQ3 of supplementary literature review described in section 8.2 in Chapter 8) most of the quality attributes mentioned in the publications retrieved for the supplementary literature review are already considered in the quality assessment framework formalised in this research. There is no major impact on the formalised quality assessment framework due to the supplementary literature and the quality index calculated for KMSS prototype. Therefore, it is clear that no major intervention to offset the conclusions made in this research.

### 9.4 Key contributions to knowledge

This thesis provides four main contributions to the body of knowledge. Firstly, the quality assessment framework derived in this research can be used in making decisions on selecting the most suitable KMS software for an organisation. This is the only framework published to date which has considered the quality assessment of a KMS in terms of learning effectiveness and which has been developed through empirical research in software engineering. The application and evaluation of the framework evidenced that it is not only theoretically sound, but also practically useful and easy to use without any special knowledge.

Secondly, this thesis also makes a methodological contribution. The Systematic Literature Review conducted in this research represents a valuable source of reference on KM, as the first SLR conducted on this topic, as well as being reported along with a step-by-step process in conducting a SLR. The mapping study, the SLR, and the associated reflections on them have since been disseminated in conferences and research symposia, and two journal articles are ready for publication. It is believed that these dissemination activities highlight the value and importance of the findings of the SLR. This SLR was conducted after developing a protocol which can be used as a roadmap for future SLRs.

Thirdly, this thesis has achieved full transparency and has explicitly shown how the quality assessment framework is formalised and evaluated. The process of formalising and evaluating this framework based on empirical methods in software engineering is a valuable reference for other researchers in carrying out similar research which allows them to look for further ways to improve this framework. Although there are frameworks and models on various aspects of KM, no systematic evidence has yet been presented in the research providing details of the process of devising a model or framework.

Fourthly, the design, implementation and evaluation of a KMSS prototype have also shown how to integrate quality attributes into real life applications of KM. Furthermore, suggestions for further improving the framework developed in this research have provided implications for the future research on KM and software engineering.

Finally, the KMSS prototype used as the test bed for this research, the empirical data collection protocol, SLR protocol and the questionnaires used for the KMSS prototype and evaluation of the framework were each newly created for the purposes of this research. All the resources developed through this research including the KMSS prototype and its components have been made freely available for use by other researchers and practitioners, allowing an original contribution beyond this thesis that can be both original and substantial.

### 9.5 Summary and limitations of the research methodology

In this research a scientific approach was identified which involved using a mixture of quantitative and qualitative research methods. In the formalisation process of the quality assessment framework for knowledge management software, various sources of empirical data were used. Specifically, the data gathered through the SLR, the evaluation of the KMSS prototype, and the evaluation of the quality assessment framework were each used as sources of empirical data at different points in this research. Frequency analysis and multi-element analysis techniques were adopted for the data analysis. Finally, a Quality Index was formulated which enables the comparative evaluation of KMS software in order to select the most suitable KMS software package for an organisation.

Limitations in the research methodology were identified at each stage of this research, and suitable precautions were implemented in order to eliminate its effect on the final outcome of the research. One of the main limitations of the SLR was identified as possible researcher bias. In order to minimise bias, and to boost the validity of the SLR findings, a sample of publications by experts in SLR was identified which used the same procedures as those used by the researcher in obtaining the present results. No anomalies were found between the data collected by the researcher and the experts identified in the SLR.

Further, data collection using questionnaire survey as its primary method has some potential limitations, such as using close ended questions, and/or using a convenience sample. Although the use of close ended questions has the disadvantage of pre-empting the factors reported in this study, it would also have strengthened the validity of the results. This is because open ended questions require qualitative data analysis techniques which are more biased than the quantitative data analysis techniques used for close ended questions. Often, the analysis of the responses to open ended questions is complex, and it is difficult to judge the levels of agreement and disagreement between participants. The other disadvantage is that collecting and analysing open ended data is more time consuming. In order to reduce researcher bias, inter-rater reliability was included in this process. Furthermore, in order to minimise the bias due to the convenience sampling employed at Keele University, UK, a similar sample was selected at the University of Colombo, Sri Lanka. The comparison of data collected from these two different geographic locations gave the data a higher level of validity, and the possible limitations in generalising the data collected through the convenience sample were therefore minimised.

There are also possible limitations in the application and evaluation of the quality assessment framework, connected with selecting a small sample of evaluators, and KMS software. It is time consuming for a single evaluator to apply and evaluate a large number of KMS software platforms. Therefore, only six KMS platforms were given to them to apply, and the quality assessment framework was evaluated by one evaluator. Application and evaluation by and with a large sample of evaluators and KMS software is suggested to raise the validity of the quality assessment framework. Furthermore, in addition to the evaluation of the quality assessment framework by regular users of the KMS software as was the case in this research, the use of additional methods of evaluation would also further minimise the limitations in this evaluation as well as improving the validity of the proposed framework.

## 9.6 Future work

This research has designed and formalised a dynamic framework that can be extended and evolved based on the feedback received from evaluators. Participants in the present evaluation felt that there was a need for an automated tool for the comparative evaluation of a range of KMS platforms in order to select the most suitable KMS platform, while also giving the reasons for that selection. The quality assessment framework in this research can be developed as a software tool that expresses the final selection as a single value representing the overall quality of a given KMS software package. As some of the participants suggested, a software tool for this evaluation would save time and minimise human errors in any evaluation. The participants also suggested that the software should include the facility to select specific quality attributes according to the needs of the organisation, and should be able to give the final evaluation with an explanation of the decision made. One of the possible directions for future work is to develop software for evaluating KMS software based on findings of this research. Furthermore, in addition to the evaluation of the framework by regular users of knowledge management software (a method which was adopted in this research), the evaluation of the framework through an expert review of the practicality and usefulness of this framework is suggested as a possible future direction which would boost the validity of the framework. Furthermore, it is suggested that the findings of the supplementary literature review could be used to consider new approaches to quality assessment of knowledge management software, and to further improve the quality assessment framework set out in the present research.

The mapping study found an additional 100 publications which were not categorised. It is suggested that this mapping study could be extended by categorising these remaining publications and searching for more publications in the literature which have been added during the interim period. Furthermore, the mapping study conducted in this research provided evidence of the research in 11 different areas of research, also indicating areas where publications were lacking. Future areas of research on KMS can be identified based on the findings of the mapping study, particularly by considering the research areas where the number of publications has not been significant in the existing literature. Furthermore, the findings from the supplementary literature review can be considered as the foundation for future research based on the recent trends in knowledge management research.

Although many prior publications in the literature have studied the quality of KMS, it was difficult to find an exact answer to RQ2 through SLR due to the lack research publications defining what quality means in KMS or e-Learning systems. Therefore, it is strongly suggested that future researchers aim to define quality in the context of KMS or e-Learning systems.

The present work has set out a framework which is both practical and easy to use without any special prior knowledge of software evaluation or KMSs. Therefore, this framework is recommended for use by individuals and organisations, and it is also hoped that researchers following up this work may make suggestions for further improving the framework with more useful and practical features.

### 9.7 Reflections on the research

This research has provided insight by linking multidisciplinary research areas. Primarily, this study is a piece of software engineering research on the quality enhancement of a special kind of software used particularly in managing knowledge. Although this research can be classified as a software engineering study, because it is related to managing knowledge, it also has links with educational research which has considered the principles of learning in the effectiveness of managing knowledge. This research has produced valuable findings which will be useful in their additions to the body of knowledge in different fields which are inter-related and multidisciplinary in nature (e.g. empirical research, software engineering, Systematic Literature Reviews, knowledge management, instructional design, e-Learning, and software quality management). The contribution of the research addresses the problem of a lack of prior research on the quality assessment of knowledge management software in the context of an organisation selecting an important element to suit its needs (KMS software). A robust and transparent framework development strategy, rarely previously found in the literature, is therefore presented in this thesis. This is a dynamic and evolving framework that other researchers can use as a reference and further improve with novel approaches. This research led its author to dissemination activities such as research papers, conference presentations, seminar presentations, invited talks and poster presentations, as mentioned in Appendix 9.1. Further publications based on it will be disseminated in the near future, and research on the new areas identified through this research will be continued.

Through this work, the researcher was able to learn the whole process of research: research design, sample selection, data collection, data analysis and reporting. Furthermore, it provided an opportunity to gain knowledge on the whole process involved in a software engineering project, which include planning, designing, prototyping, implementing and evaluating. Project management skills were vital, and were enhanced through this research. Critically analysing the existing research and applying suitable techniques at each stage of a research project was necessary to achieve a novel research outcome. The strong foundation laid through goal-oriented research will be reflected in the future in my research and academic career.

-End-

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# Appendix 2.1: Data collection protocol

# A quality assessment framework for knowledge management software: empirical data collection protocol

## 1.0 Introduction

The empirical data collection procedure adopted in the study on quality assessment framework for knowledge management software is presented in this protocol. The development of a protocol will help to ensure that a reliable, transparent and rigorous study is performed (Yin 2009). Furthermore, potential problems have been identified and accounted for in advance of its implementation. The protocol may also acts as a point of reference for other researchers interested in performing empirical data collection.

## 2. 0 Background

Knowledge has become a strategic asset to any organisation due to its usefulness for innovation, performance improvement and competitive advantage. In order to get the maximum benefit from knowledge, managing various forms of knowledge is increasingly viewed as an important aspect. A Knowledge Management System (KMS) is a class of Information System (IS) that manages organisational knowledge. Knowledge Management System Software (KMSS) is a component of a KMS that can be used as a platform for managing various forms of knowledge. Evaluation of effectiveness or quality of knowledge management software is challenging. There is not much systematic evidence on methods used for evaluating knowledge management software quality by considering various aspects of Knowledge Management (KM) to ensure the effectiveness of a KMS. The aim of this research is to device a quality assessment framework for knowledge management software.

### 2.1 Aim and objectives

The overall aim of this research is to device a quality assessment framework for knowledge management software. This aim will be achieved through seven objectives mentioned below.

1. Examine the existing research on KMS.
2. Review of learning theories to use as the basis for creating a learning environment in prototype of KMSS.
3. Qualitative selection of a KMS platform for designing a prototype of KMSS.
4. Designing and implementing a prototype of KMSS to use as a test bed for data collection.
5. Empirical data collection for evaluating quality attributes of a prototype of KMSS.
6. Formalisation of the quality assessment framework for knowledge management software.
7. Application and evaluation of the quality assessment framework for knowledge management software.

The aim and objectives of this research will be achieved through the review of research methods in software engineering. This review provided the background knowledge to identify the most suitable research method for this research. In essence, this research will be carried out in stages identified as Systematic Literature Review into KMS, overview of learning theories, qualitative selection of KMS software, design, development and evaluation of a prototype of KMS software, formalisation of the quality assessment framework and application and evaluation of the quality assessment framework for knowledge management software.

The objective of the data collection methods explained in this protocol is to provide more validity to data collected from the Systematic Literature Review (SLR) and to evaluate the quality assessment framework. This protocol is developed based on the guidelines described by Brereton (Brereton, et. al. 2008).

### 3.0 Research methodology

In order to achieve the above mentioned aim and objectives, the research will be carried out in stages identified as 1. Systematic Literature Review (SLR) into KMS, 2. Overview of learning theories, 3. Design, implementation and evaluation of a KMSS prototype, 4. Formalisation of the quality assessment framework for knowledge management software and 5. Application and evaluation of the quality assessment framework for knowledge management software (Figure 1).

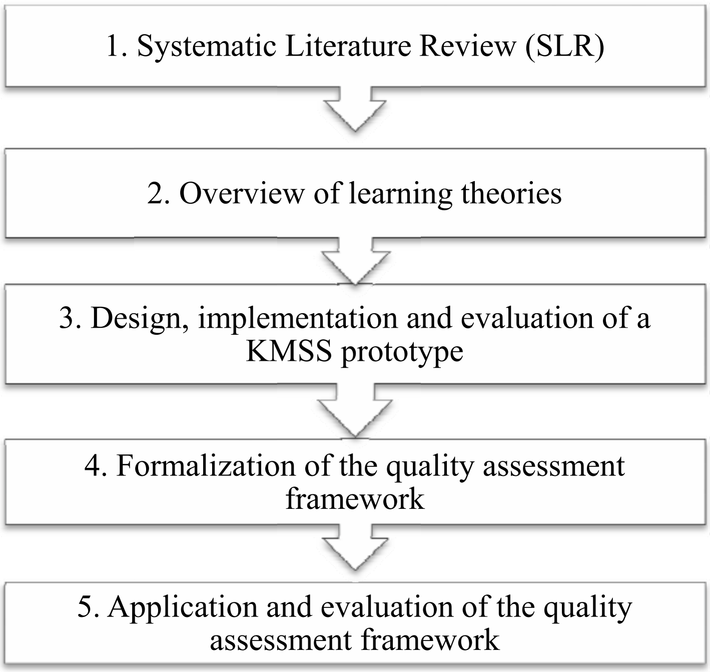


Figure 1 Stages of research

Systematic Literature Review (SLR) methodology has been used to identify related work on KMS and to investigate how it will apply to this research. In order to select the most suitable KMS platform for this research, qualitative selection of a KMS platform will be conducted by comparing the quality features of 15 widely used KMS platforms. Learning is the elementary requirement to manage knowledge in KMS software. Learning theories were reviewed as guiding principles for designing learning tasks in the learning environment in the selected KMS software. The quality attributes of knowledge management software will be evaluated by giving learning tasks in a KMSS prototype. A questionnaire survey and the academic performance for the given learning tasks will be used to evaluate the quality features of the KMSS prototype. Based on the analysis of results from data collection through evaluation of a KMSS prototype and Systematic Literature Review (SLR), the quality assessment framework will be formalised. The quality assessment framework will be applied on KMS platforms by a sample of evaluators and overall Quality Index formulated based on multi-element analysis technique will be used to evaluate the overall quality of a selected set of KMS platforms.

This protocol explains the data collection and analysis procedure for accomplishing the stages of this research.

**4.0 Data collection and analysis**

Data collection for this research has three stages.

Firstly, for the identification of quality attributes of knowledge management software, a Systematic Literature Review (SLR) process was used (Kitchenham and Charters, 2007a, Kitchenham and Charters, 2007b). A systematic review is a defined and methodical way of identifying, assessing, and analysing published primary studies in order to investigate a specific research question. Systematic reviews differ from ordinary literature surveys by being formally planned and methodically executed. They are intended to be independently replicable, and so have a different type of scientific value as compared to ordinary literature surveys. In finding, evaluating, and summarising all available evidence on quality assessment of knowledge management software, a systematic review may provide a greater level of validity in its findings than might be possible in any one of the studies surveyed in the systematic review. In this research Systematic Literature review was carried out before empirical data collection using this protocol. A systematic review protocol was designed first in order to perform the Systematic Literature Review. The results of Systematic Literature Review has been already gathered and presented in Chapter 3 of the thesis.

Secondly, the users' perceptions on quality attributes of a KMSS prototype will be gathered through a questionnaire survey. Questionnaire survey is a widely used method of data collection in software engineering to gather data from users' experience in using software. Section 4.1 in this protocol describes the details of questionnaire survey. In addition to the questionnaire survey, data will be gathered from the evaluation of academic performance of users for given assessment tasks. Section 4.2 describes the method of collecting data by evaluating the academic performance of users of KMSS prototype.

Thirdly, data will be gathered in order to evaluate the proposed quality assessment framework by applying it to evaluate KMS platforms. Section 4.3 describes the method of data collection for the evaluation of the quality assessment framework for knowledge management software.

The multiple sources of data mentioned above will be used for data triangulation which will strengthen the findings of this study due to it allowing for converging lines of enquiry and corroboration. Triangulation involves taking multiple measures of a studied object and is relevant for qualitative, quantitative and mixed method studies (Runeson et al 2012). Triangulation also helps to address the potential problem of construct validity (discussed in Section 5). The collected data will be made available to secondary investigators and will help to ensure the transparency of the data collection process. A chain of evidence will also be established.

**4.1 Data collection through evaluation of a KMSS prototype using a questionnaire survey**

This section explains the data collection through evaluation of a KMSS prototype using a questionnaire survey. As Figure 1 depicts, the primary steps of the questionnaire survey design process included 1. Constructs Operationalisation, 2. Instrument Design, 3. Sample

Selection 4. Pilot Testing, 5. Conduct Survey, 6. Data Cleansing and 7. Analysis and Reporting. Even though the steps are depicted in a sequential manner, it is largely an iterative process. For an example one has to know the sample profile to be able to finalise the items and wordings in the instrument but the fundamentals of what is going to be measured has to be decided in order to identify the best candidate to respond to the questionnaire survey. Similarly, the data has to be cleaned and codified prior to data analysis, but further data manipulation and codification may be required as part of the data analysis process. The above mentioned stages of data collection are described in section 2.7 in Chapter 2 of the thesis.

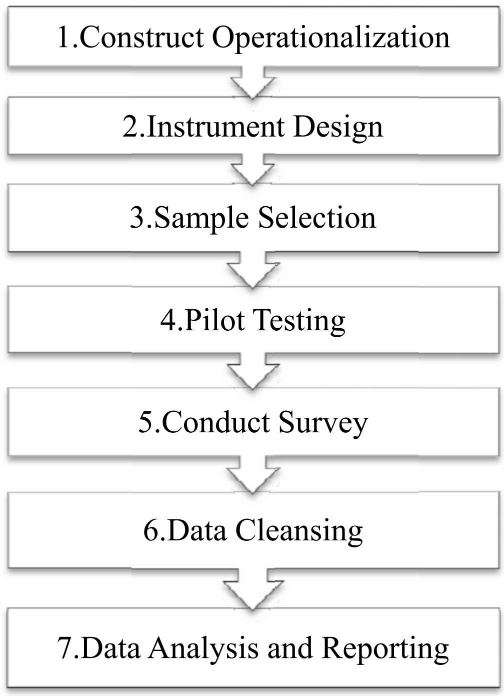


Figure 2 Stages in a questionnaire survey

### 4.1.1 Construct operationalisation

Construct operationalisation is the process of identifying constructs and related sub-constructs for each construct (in this study these were already identified through systematic literature review), deriving suitable items (survey questions) for each of the sub-constructs and identifying a measurement scheme. This is a task that is normally iteratively revisited in a questionnaire survey. For an example selected items may be modified in relation to the feasibility and characteristics of the available sample or the results of the pilot testing (step 4 in Figure 2).

The terms construct, sub-construct, items, questions, metric are used frequently in this discussion. Relationship between the key terms used is described in Figure 3.

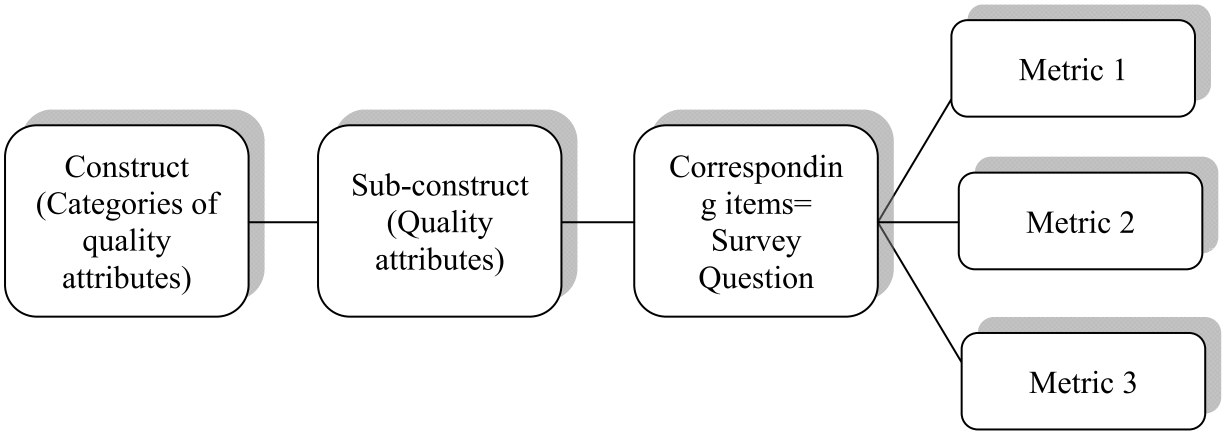


Figure 3 Relationship between key terms: 'Construct', Sub-construct', 'Item', 'Question' and 'Metric'

The operationalisation process of this study has already completed in the previous stage in Systematic Literature Review by identifying constructs (quality attributes categorised in to platform quality, content quality and user satisfaction) and sub-constructs (related quality attributes under three main categories). Initially there were 58 quality attributes identified through literature. The most applicable quality attributes were identified by considering the frequency of occurrence of each quality attribute in SLR. By analysing the attributes with similar meaning and the importance to evaluate the learning effectiveness through KMSS, the number of attributes was reduced to 41. More details of the process adopted in identifying the constructs and sub-constructs were discussed in Chapter 3 under Systematic Literature review and Chapter 4 Designing Quality Assessment Framework. Brief description of each sub-construct to be evaluated and the questions under each sub-construct are given under three main constructs (Appendix 2.3 of the thesis).

Defining a set of measurement metrics is one of the most important issues in any evaluation process for quantitative evaluation of the quality levels and to facilitate decision making (Alfonso et.al., 1998). A goal oriented measurement strategy called Goal Question Metric (GQM) approach was adopted to identify a measurement strategy in this research. Next section focuses on the metric identification using GQM approach to quantify the quality attributes in order to evaluate the overall quality of knowledge management software.

**Overview of Goal Question Metric (GQM) approach**

Goal Question Metric (GQM) approach, a goal-oriented measurement strategy consists of deriving measures from measurement goals to ensure the consistency and completeness of measurement plans was adopted in this study to identify metrics for each quality attribute. GQM approach is an approach to software metrics that has been promoted by Victor Basili explained in (Basili et.al, 1994). The approach was originally defined for evaluating defects for a set of projects in the NASA Goddard Space Flight Center environment. The application involved a set of case study experiments. Although the approach was originally used to define and evaluate goals for a particular project in a particular environment, its use has been expanded to a larger context (Basili et.al, 1994).

This approach is based upon the assumption that to measure in a purposeful way, first the goals of the project should be specified. Then goals should be traced to the data that are intended to define those goals operationally, and finally provide a framework for interpreting the data with respect to the stated goals (Basili et.al, 1994). The quantified information can be analysed to determine whether the goals were achieved (Basili et.al, 1994, Chen et.al, 2003, Latum et.al, 1998, Khamis et.al. 2007)

Application of GQM defines a measurement model on three levels in our research:

*Conceptual level (goal)*
A goal is defined for each quality attribute.

*Operational level (question)*
A set of questions is used to define each quality attribute; the answers to these questions could be used to determine whether the specified goals were met.

*Quantitative level (metric)*
A set of metrics is defined, based on the quality attributes, associated with every question in order to answer it in a measurable way.

By using the GQM approach, many current approaches to measurement are combined and generalised; these include processes and resources as well as product assessments. This approach is, therefore, flexible to be used in different environments; it has been applied in numerous organisations, including: NASA, Hewlett Packard, Motorola and Coopers & Lybrand (Basili et.al, 1994).

Figure 4 depicts the application of Goal Question Metric approach in this study. A GQM model is a hierarchical structure (Figure 4) starting with a goal (specifying purpose of measurement, object to be measured, issue to be measured, and viewpoint from which the measure is taken). The goal is refined into several questions that usually break down the issue into its major components. Each question is then refined into metrics, some of them objective and some of them subjective. In this study subjective measures were obtained for each goal (using a questionnaire survey). The same metric can be used in order to answer different questions under the same goal. Several GQM models can also have questions and metrics in common, making sure that, when the measure is actually taken, the different viewpoints are taken into account correctly (i.e., the metric might have different values when taken from different viewpoints, (Basili et.al, 1994)). After the measures have been specified, we need to develop the data collection mechanisms, including validation and analysis mechanisms.

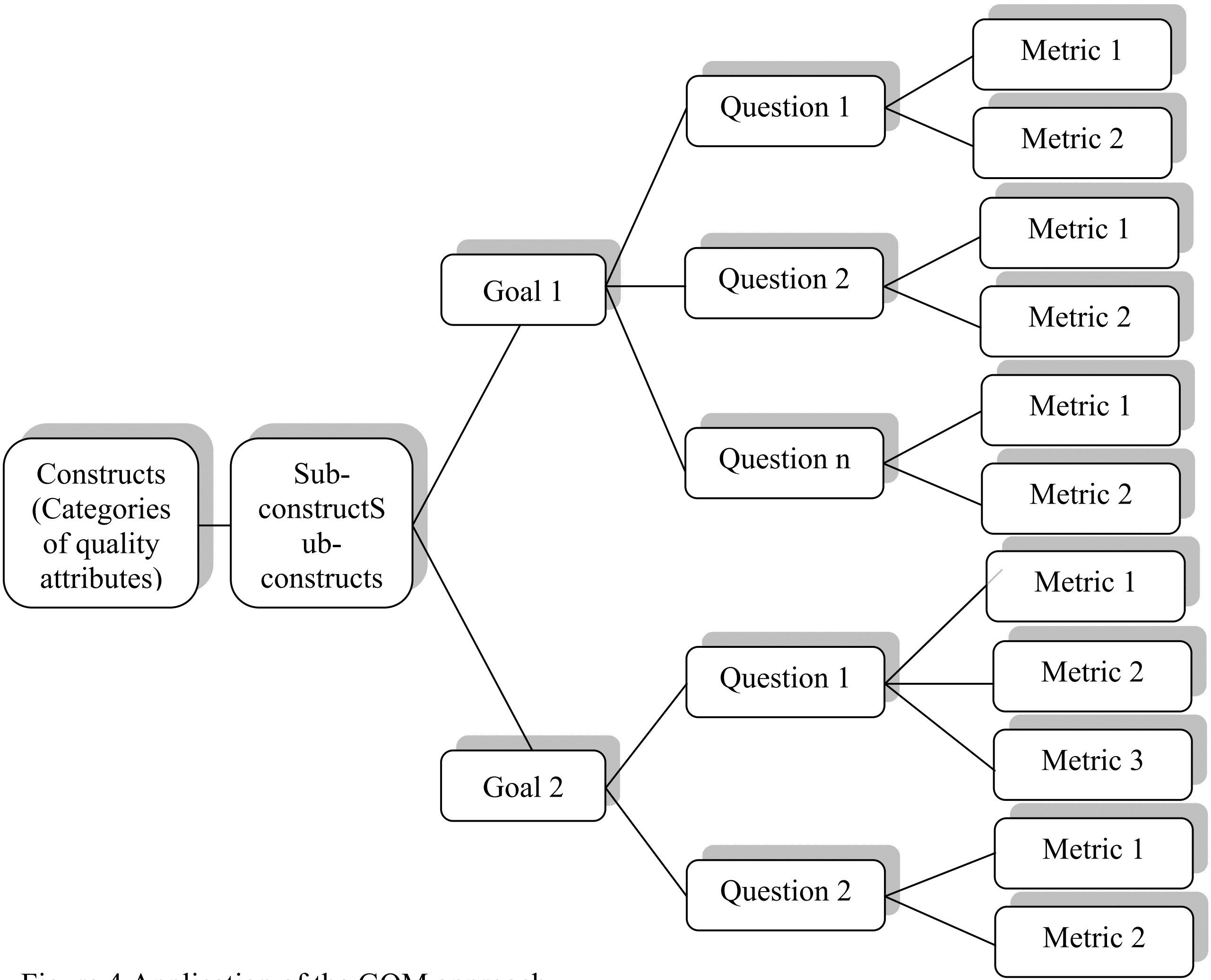


Figure 4 Application of the GQM approach

**Identifying goals**

The starting point to GQM approach is to identify quality goals. This stage is one of the important and critical stages in ensuring the successful application of the GQM approach. At the end of this stage, a set of goals associated with each quality attribute should be identified. Constructs and sub-constructs identified in a previous stage (SLR explained in chapter 3 of the thesis) was used for defining goals, questions and metrics. For each quality attribute brief description of quality attribute is defined based on the information gathered from the origin of the quality attribute and the features of KMS platforms identified in a previous stage. Goal of each quality attribute in the quality assessment framework was identified (Appendix 2.3 of the thesis).

Goals should be defined by specifying purpose of measurement, object to be measured, issue to be measured, and viewpoint from which the measure is taken. The example of goal setting for the "easy to use" attribute can be represented as follows: for the purpose of quality measurement (purpose), evaluate the ease of use (object), with respect to KMS platform quality (issue to be measured), from the users' viewpoint (viewpoint), in a given KMS platform (environment). See Figure 5 for an example of application of GQM approach in this research.

**Deriving questions**

The identified goals are then used to formulate relevant questions, to provide clearer definitions of the goals and to relate quality metrics in order to measure the quality in a quantifiable way. Based on the goals identified in the previous stage and based upon models of the object of measurement, questions that define those goals as completely as possible were derived.

These questions should be defined in a manner that allows the answers to provide measurable values. To illustrate, it to focus on the goal mentioned previously could be represented as: B1: KMSS is easy to use, B2: I can find the required information easily, B5: Help in the system is useful, B6: Graphical user interface of the KMSS is user friendly. Figure 5 provides more details on formulating questions.

This stage describes how the sub-constructs (quality attributes) were converted to survey questions in our survey questionnaire design. Once the sub-constructs for each construct was identified, the next step was to derive survey questions or items for the selected pool of sub-constructs. Survey items can be fixed-choice (where the respondents select his/her response from a set of options given) or open-ended (where the respondents are allowed to enter their own responses to a given question).

The number of items to measure a sub-construct should adequately sample the domain of interest, but still be parsimonious as possible (Cronbach and Meeh, 1955). Surveys with too many items can induce response pattern bias while those with too less may jeopardize content and construct validity (Anastasi, 1976 Nunaly, 1978).There may be one or more items for each sub-construct.

The publications in the SLR were reviewed in search of the best potential questions for each sub-construct. Best suited multiple items were derived to evaluate each sub-construct. Overall results after identifying construct and sub-construct were presented to the group of experts in software engineering and instrument design. Their feedback was also incorporated into deriving questions for sub-constructs.

**Identifying metrics**

The next step in GQM approach consists of specifying the measures that need to be collected in order to answer those questions. In other words, these measurable metrics are used for quantifying responses to questions. The values derived from these metrics will be used later to calculate the quality score for each quality attribute for three categories of quality attributes and for overall quality. For this purpose, the responses obtained from the questionnaire survey are quantified using descriptive statistical measures. Average of responses for the questions under each quality attributes were considered to calculate a single value metric for each quality attribute (sub-constructs).

An example of application of goal question metric approach is given in figure 5.

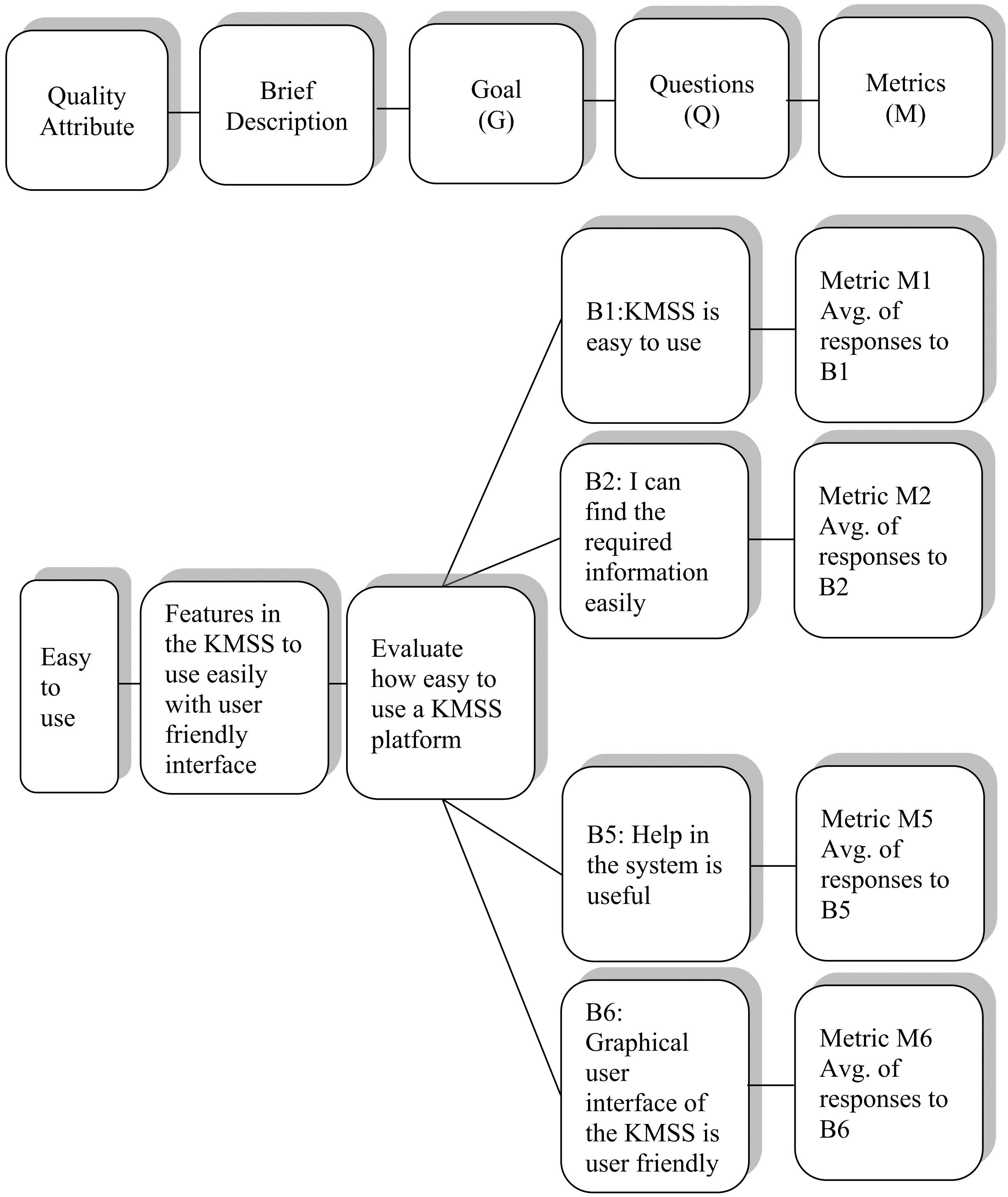


Figure 5 An Example for application of the GQM approach

### 4.1.2 Survey instrument design

A questionnaire survey will be used to ascertain the user's perception on quality of a knowledge management software by giving rates for the attributes in the proposed quality assessment framework. In survey instrument design the selection, wording and order of questions and answers requires careful thought and reasonable command of language (Fink & Kosecoff, 1985).

Each question in the questionnaire related to one or more quality attributes and vice versa. A 5-point Likert-type scale was used to rate the quality attributes that will be evaluated through each question. The answers to the questions are a choice of 1-Strongly Agree, 2-Agree, 3-Neutral, 4-Disagree and 5-Strongly Disagree.

The familiar words for users that reflect each attributes were identified by considering the features on the KMS platforms identified in a previous stage (in comparing KMS platforms). Questions are formulated in order to measure quality attributes of knowledge management software in a quantifiable way. Questions derived using GQM approach (Appendix 2.3 in the thesis) was used in designing the instrument given in Appendix 2.4 in the thesis. Quality attributes of the tutorial content quality are evaluated through the responses to questions A1 to A14. Quality attributes related to platform quality are evaluated through the responses to questions B1 to B12. User Satisfaction is evaluated through questions C1 to C8.

The first version of the survey instrument was drafted after consolidating the results presented up to now. A number of elements had to be addressed prior to deriving a complete instrument. This section addresses these elements in detail.

**Instructions**

Questionnaires should be self-explanatory, to be able to fill out in privacy without supervision. They must consist of general instructions on the overall survey and specific instruction (when deemed relevant) for different sections within the instrument (Fink & Kosecoff, 1985). A thorough concern was given to this study to abide by these recommendations and clear instructions were provided (see appendix 2.4 for a copy of paper based instrument).

**Construct labelling and definitions**

Many human attitudes and feelings are subject to a range of definitions (Fink and Kesecoff, 1985). For an example, in this study's survey, definitions are given for 'platform quality', 'content quality' and 'user satisfaction'.

Even when "*one is not measuring theoretical ideas.... you must define you must define your terms ...It is best to adopt a respected point of view....and when possible, an already existing and tested survey form*" (Fink and Kesecoff ,1985). Hence all the constructs that were included in the study were introduced with a definition (see appendix 2.4 for a copy of paper based instrument). These definitions were derived after reviewing definitions that were identified from literature, reviewing the instrument by experts and pilot testing rounds of the instrument. They were provided to assist the respondent understand the concept that was going to evaluate by the proceeding survey items. Furthermore, the individual items were edited and phrased to suit the respondents', according to the target sample.

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**Item wording**

Items that belonged to one construct were grouped together. These were always preceded by construct definitions as described in the previous section. There were criticisms in literature on positively and negatively wording of items. It was evident that there are pros and cons of both positively and negatively wording the items. However, in this study we used positively worded items. Each item was reviewed several times with the supervisor with the goal of avoiding any occurrence of long complex questions, double negatives and any jargons or abbreviations, words with double meanings, leading questions and emotionally loaded questions.

**Selecting the scales**

A scale refers to the choice a respondent has on answering each item and this can be designed in multiple different ways (e.g. via categorical, comparative, differential, graphical, interval, nominal, ordinal, ration or summated scales, (Fink and Kesecoff ,1985 )). Using the appropriate scale is an important consideration of the instrument design process, specially when it is used for evaluating constructs (quality attributes). There are many validated scales that can be used in research. Finding the right one(s) for a particular research is challenging. The constructs in this study were designed primarily to gather users' perception on the constructs via a range of sub-constructs identified in SLR. Close ended Likert style questions were designed for this purpose.

Likert type scales have been used by researchers for decades since its original development in 1932 by Rensis Likert (Hodge & Gillespie, 2003). This type of scale consists of a series of declarative statements, where respondent is asked whether s/he agrees or disagrees with each statement. Likert scales are acknowledged to be the most frequently used scale in users' perception gathering in general and information technology related surveys. It also fit well with the purpose of the questionnaire survey in this study. Length of the scale (e.g. 1 to 5; 1 to 7; 1 to 10) is an important decision to be made by the researcher. Five point scales ranging from Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree was used for this study.

**Designing the overall layout and order of questions**

Appendix 2.4 illustrates a copy of the paper-based survey instrument, which clearly denotes the overall layout that was followed. In the first page brief introduction to the study and its goals and general instructions was given before the actual questionnaire items. The smooth flow within the questions was carefully followed according to the basic guidelines provided by Fink and Kesecoff (1985). The purpose of the questionnaire survey was to gather users' perception of the quality of KMSS but not the MySQL software that was used in executing learning activities. Therefore clear instructions were given for respondents to consider the KMSS platform but not the MySQL software.

Survey questions were presented in one flow and there are three sections in the questionnaire. Sections are identified by considering the sequence of tasks performed in using the KMSS prototype before responding to this questionnaire. A learning content is given as a component of the KMSS (e.g. video tutorial, learning materials, note book, quiz, and practical test). Therefore, questions related to content quality features are given in the first section (Section A) of the questionnaire. Questions related to KMSS Platform quality were given in section B of the questionnaire. Questions related to user satisfaction features are given in the third section (Section C) of the questionnaire. At the end of the sections A, B, and C, three open ended questions were given to get user's perceptions on positive and negative features of the KMSS.

**Validation of the questionnaire**

The questionnaire was reviewed by the supervisor and the suggestions for the amendments were considered for changing the order and wording of the questions. Additionally, the questionnaire was reviewed by software engineering and questionnaire design experts in the School of Computing and Mathematics. Furthermore, a seminar presentation was conducted to get the feedback from researchers in the School of Computing and Mathematics. Two colleagues reviewed the amended questionnaire as the post review before the actual data collection.

### 4.1.3 Sample selection

The learning activities in the prototype of a KMSS will be designed on "Introduction to Database Technology using MySQL". Therefore, the criteria for selecting participants are those who are computer literate and new to learning database management concepts. A sample of 30 respondents will be selected from the students in the undergraduate and post graduate programmes (who haven't studied the Database Technology module) of the School of Computing and Mathematics, Keele University. In order to identify the similarities and differences in data from different geographic areas, a similar sample of 30 participants will be considered from University of Colombo, Sri Lanka.

### 4.1.4 Pilot testing

A pilot testing phase will be conducted by inviting 5 participants to carry out the tasks as for the planned data collection .The participants will be students of the School of Computing and Mathematics, Keele University. The participants will be explained the purpose of their participation and request for their participation will be sent via e-mail. A feedback gathering sheet will be given to the participants. Feedback on overall process of data collection, layout of the questions in the questionnaire and overall timing to complete the questionnaire will be systematically gathered, consolidated, and integrated to derive an improved version of the survey.

### 4.1.5 Conducting the survey

The participants will be invited by sending an e-mail (Appendix 2.5 of the thesis) to participate for a data collection session that will be held in School of Computing and Mathematics. The data collection through a questionnaire survey will be followed by carrying out the given learning activities and assessment tasks in the prototype of a KMSS platform. Figure 6 depicts the sequence of tasks that will be carried out by the invited participants.

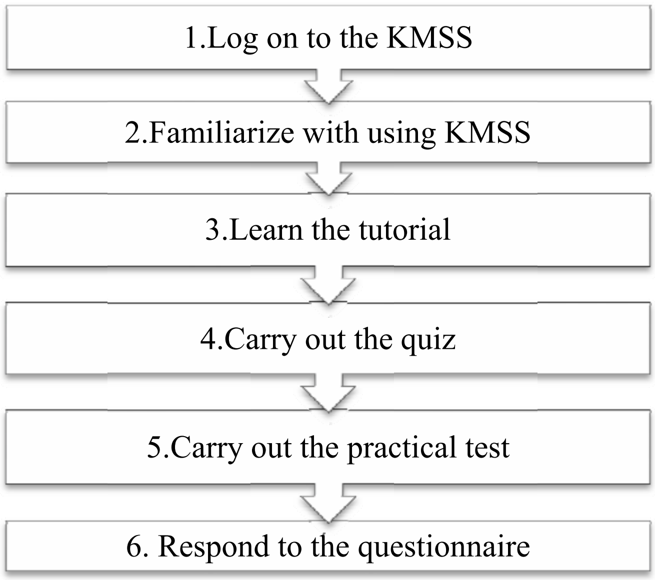


Figure 6. Tasks to be carried out by survey participants

Following section describes the activities that will be carried out in each task given in Figure 6.

*1. Log on to the KMSS:* Users will be given a user name and a temporary password to logon to the KMSS. Temporary password should be changed in the first log on to the KMSS.

*2. Familiarise with using KMSS:* Users will be able to familiarize in using the following main components of this prototype.

- Home page: Use the menus in the left and top ribbon and links in the body of the main page.
- Notebook: Use as a reference material and edit the contents in the note book
- Learning Materials: Use additional learning materials
- Blog: Read and add blog post
- Survey: Take the survey
- Announcements: Read and add announcements
- Task List: Create a task list
- Discussion Board : Participate for discussions by posting comments
- Wiki: Read and add wiki contents
- Calendar: View and create a calendar
- Contact Us: View the contact information
- Outlook: Create and use a mail box
- People: Add contacts
- Newsfeed: view and add newsfeed
- SkyDrive: Use cloud based storage facility

*3. Learn the tutorial:* Learn Introduction to Database Technology using the video tutorial and supporting materials in the KMSS.

*4. Carry out the quiz:* A link to quiz will be given to users. User login information to the quiz is given prior to taking the quiz.

*5. Carry out the practical test:* Users will be given a practical test to carry out the given assessment tasks in MySQL.

*6. Respond to the survey:* A link to the questionnaire will be given.

The above mentioned tasks are designed by considering the quality attributes that will be rated by responding to the questionnaire.

In this study a web-based instrument which is similar to the instrument given in Appendix 2.4 of the thesis will be given in the KMSS platform. Literature provides varying debates on the pros and cons of using electronic surveys. But most of the studies today use electronic surveys due to low cost, ease of administering, distributing with less time and analysis of results using responses stored compared to paper based instruments (e.g. cost for printing and distributing by mail with prepaid envelops). In the context of this study, the advantages of web-based instruments outweighed any limitations. The target population of this study is undergraduate students who are computer literate. The data collection is followed by taking part in a range of activities given to use a KMSS platform and therefore, web-based instrument simplifies the data collection for this study.

### 4.1.6 Data cleansing

The responses to the questionnaire will be collated, cleaned and codified before analysis. Researcher memos will be maintained throughout this process, as the notes taken at this stage could be used in a future replication study that would utilise this instrument. The missing values will be identified and a data cleaning rule will be used for two open ended questions.

### 4.1.7 Analysis of data

**Frequency analysis**

One of the ways of organising qualitative data is to group scores or values into frequencies (Black, 1999). Frequency analyses are helpful for treatment of descriptive information. Frequency of occurrences and percentages of each data variable can then be reported using the frequency tables. These frequencies are helpful for comparing and contrasting within groups of variables or across groups of variables and can be used for both nominal/ordinal as well as numeric data. In this research frequency analysis will be used for analysing data collected through SLR and questionnaire survey. The method of application of the frequency analysis in this research is given below.

Firstly, through the SLR the frequency of occurrence of each attribute will be calculated. Secondly, through the questionnaire survey, frequency of responses to questions for "strongly agree" and "agree" categories of responses related to each quality attribute will be calculated. If there are more than one question for a quality attribute, a single value metric for each quality attribute will be computed by considering the average of responses for the questions under each quality attribute (as explained under 'Identifying metrics'). Thirdly two data sets will be compared and similarities and differences will be identified.

**4.2 Data collection through evaluating academic performance**

Learning effectiveness is one of the parameters that imply the quality of a learning environment. In this study it is considered that higher score for the assessment tasks will be attained if the KMSS platform provided a robust learning environment for achieving learning outcomes. For this purpose assessment tasks (quiz and a practical test) will be given to users to complete after learning through KMSS. The overall score and the grade for these assessment tasks will be considered to evaluate the effectiveness of learning. The process of data collection through evaluating the academic performance is illustrated in Figure 7.

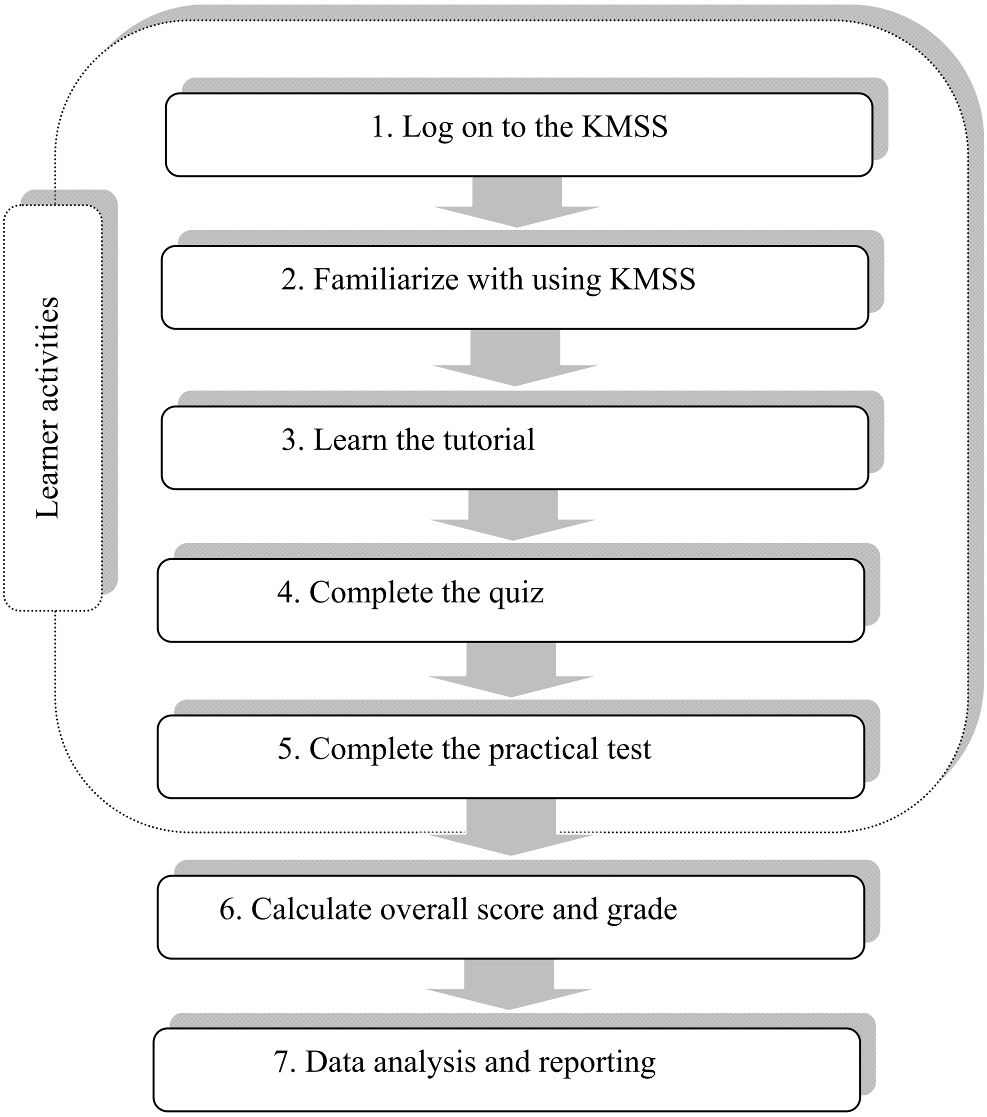


Figure 7 Data collection through evaluating academic performance

As figure 7 depicts, the learners will be given learning activities on “Introduction to Database Technology using MySQL”. The assessment tasks given include a quiz and a practical test to measure the deep learning occurred through using KMSS. Clear instructions will be given to complete the quiz and the practical test. Score for the quiz will be automatically stored in the quiz data management component. The results of the practical test submitted by the participants will be evaluated by giving scores for each assessment task in the practical test.

Overall score will be calculated by adding the sore for quiz and practical test. Based on the overall score, grades will be assigned as given in Table 1.

**Grading structure**

Marks for Practical Test 50%

Marks for Quiz 50%

Total Score is the sum of marks for the practical test and quiz.

| **Total Score (100%)** | **Grade** |
|---|---|
| >=75 | A |
| >=60 and <75 | B |
| >=40 and <60 | C |
| <40 | D |

Table 1 Grading structure for assessment tasks

Frequency of the grades A, B, C and D will be considered to evaluate the learning effectiveness. In this study achieving grades A and B to the assessment tasks will be considered as an indication of good academic performance and learning effectiveness due to learning through KMSS.

**4.3 Data collection for evaluation of quality assessment framework**

This section describes the evaluation of the formalised quality assessment framework for knowledge management software. There are many software evaluation schemes in the literature addressing software process quality and product quality. Selecting a suitable evaluation scheme is challenging. Having an established and documented process to perform the selection and evaluation in a consistent and repeatable manner is useful for objective evaluation of software (Bandor, 2006). A successful evaluation is not simply picking a product based on intuition. It involves a formal process, the right mixture of evaluators, and a specific quantifiable set of evaluation criteria. The process should include how to handle differences in evaluation by the evaluators. Proposed evaluation method can be used to assess and compare KMS platforms by a single evaluator or a sample of evaluators to choose a KMS platform that gives the most of the quality features in the quality assessment framework. For unbiased objective evaluation, a sample of evaluators was considered in this evaluation. The evaluation criteria, method of evaluation and results of the evaluation are presented in the Chapter 7 of the thesis.

**5. 0 Plan validity and reliability**

The measures which have been taken to ensure the validity of the data collection methods are presented in this section.

In order to ensure the rigour and reliability of the data collection, several measures have been taken. As documented in Appendix A, this protocol has been designed after considering Per Runeson and Martin Höst's case study design checklist (Runneson and Höst 2009).

**5.1 Construct validity**

As suggested by Yin (Yin 2009) construct validity will be strengthened within this study through the use of multiple sources of evidence (questionnaire survey, practical test and quiz), establishing a chain of evidence (managing a well-structured database of collected data, the final report to refer heavily to collected evidence, the protocol procedures to be followed and deviations documented) and expert review of draft protocol and reports.

**5.2 Internal validity**

Internal validity relates to the genuineness of claimed casual relationships. As suggested by Yin (Yin, 2009) internal validity is a primary concern in casual case study designs. Concerns of internal validity should apply to the many instances when the investigator makes inferences based on the collected data (i.e. that an observed outcome is attributable to some prior occurrence or concept). Replication with pattern matching and explanation building will be used to address internal validity of the data collection methods explained in this protocol.

**5.3 External validity**

External validity refers to the extent to which the findings of investigation can be generalised. As the participants for data collection using questionnaire survey and evaluating academic performance (sections 4.1 and 4.2) in this study are undergraduate students in the Keele University and University of Colombo, Sri Lanka. It is believed that the results will be generalisable to similar novice learners.

**5.4 Reliability**

Reliability of the data collection methods explained in this protocol relates to the extent to which the investigation would achieve the same results if it were repeated. Reliability will be enhanced through the use of a detailed protocol and a well-structured document of collected data.

Furthermore, as this protocol has undergone expert review, in addition to peer review, the risk of unidentified threats to the validity of the study are considered to have been minimised.

**6. 0 Limitations**

The instruments that will be used during the data collection will collect data that is self-reported. Therefore, cannot be independently verified and the responses to the questionnaire has to be taken at face value which may lead to sources of bias such as selective memory and exaggeration. It is intended that the anonymous nature of the data collection and the use of closed and open ended questions without leading participants will be helpful to reduce the potential impact of self-reported bias.

**7.0 Keele ethical requirement**

Before conducting this research an ethical application was approved by the Ethics Review Panel at Keele University, UK. The project was approved by the Dr Bernadette Bartlam Chair – Ethical Review Panel, dated 13th May, 2013. The researchers planned the data collection procedure to meet the ethical requirements, i.e. protection of subjects from any damage, deception and loss of privacy. The dignity and interest of participants will be respected at all times. All the participants will be informed that all information gathered from users is used for research purposes only. Such information will be treated in the strictest confidence and any publication from this study will present information in aggregate form such that individual respondents participating in the research cannot be identified. Participant can withdraw their participation at any time during this project. Data collected from participants will be stored securely in accordance with the Data Protection Act 1998. Only the researcher and the supervisory team will have access to the data. Additionally, participants will be informed about the nature of the research, through information documentation. Informed and written consent forms will be received from all participants prior to conducting data collection of the study.

**8.0 Storage of data**

The data collected will be stored in a password protected secure computer to use by the researcher. Ethical requirements explained in section 7 of this protocol will be considered strictly in storing and using the collected data.

**9. Potential conflict of interest**

Not known

**10.0 Divergences**

In case of any divergence from the protocol, which may occur during the study, we will note down any change in a new Appendix to this document.

**11.0 Roles of research team**

The main researcher will design and administer the data collection sessions and the lead supervisor will be an observer of the data collection sessions. The supervisory team will review the data collection procedure explained in this protocol and will be consulted as the study progresses in gaining research support and advice.

**12.0 Protocol review/validation**

The protocol will initially be reviewed by the first supervisor and any suggestions for amendments will be considered. It will also be reviewed by an independent reviewer and two colleagues as post review. Reviewers' suggestions will be taken in to account for amendments to the protocol. Furthermore, the data collection methods proposed in this protocol was reviewed by the experts in software engineering through following events.

- Seminar presentation at School of Computing and Mathematics, Keele University

- Poster presentation at Doctoral symposium, Department of Computer Science, York University

**13.0 Reporting**

The information discovered will help in making decision on selection of a suitable KMS platform for an organisation, particularly by considering its quality aspects. The researcher will disseminate the results of this research in thesis, conferences and journal articles subject to confidentiality issues of maintaining secrecy for individuals.

**14.0 Schedule**

Given below is the schedule for the data collection of this research. There is no significance if any of the stages takes longer than expected.

| Activity | Duration |
|---|---|
| Planning | One Week |
| Protocol Development | Two Weeks |
| Protocol Evaluation/Implementation | One Month |
| Data Analysis | Two weeks |
| Reporting | One month |

**15. 0 Summary**

This protocol provides details of data collection methods that will be used for formalisation of the quality assessment framework for knowledge management software. The data collection methods described will be used after conducting a Systematic Literature Review. The development of a data collection protocol in advance of the data collection will help to ensure that reliable, transparent, targeted and rigorous work is performed. Furthermore, several measures have been taken to identify potential problems which may affect the study and accounted for in advance of its implementation. This protocol provides background information about this research, details of the planned research methodology, information about the data collection and data analysis strategies and a consideration of factors which could affect the validity of the study. This protocol may also act as a point of reference for other researchers interested in performing empirical data collection.

**References**


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Runeson, P. and Höst, M., 2009. Guidelines for conducting and reporting case study research in software engineering. Empirical Softw. Engg. 14 (2), pp. 131-164.

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Yin, R. K., 2009. Case Study Research: Design and Methods (4th Edition). Sage.

**Appendix A: Höst and Runeson's (2009) checklist items**

| Item | Checklist question | Comments |
|---|---|---|
| 1 | What is the case and its units of analysis? | See Section 3.0-Research Methodology |
| 2 | Are clear objectives, preliminary research questions, hypotheses defined in advance? | See Section 2.0-Background |
| 3 | Is the theoretical basis - relation to existing literature or other cases - defined? | Results of a previously completed SLR provide the basis for this study |
| 4 | Are the authors' intentions with the research made clear? | See Section 2.0-Background |
| 5 | Is the case adequately defined (size, domain, process, subjects…)? | See Section 4.0- Data Collection and Analysis |
| 6 | Is a cause–effect relation under study? Is it possible to distinguish the cause from other factors using the proposed design? | See Section 5.0- Plan Validity and Reliability |
| 7 | Does the design involve data from multiple sources (data triangulation), using multiple methods (method triangulation)? | Multiple forms of data using multiple data collection methods will be used and collected data will be triangulated as outlined in Section 4.0- Data Collection and Analysis |
| 8 | Is there a rationale behind the selection of subjects, roles, artefacts, viewpoints, etc.? | Yes. This is described throughout the protocol document |
| 9 | Is the specified case relevant to validly address the research questions | See section 5 Plan Validity and Reliability and 12.0 Protocol Review/validation |
| 10 | Is the integrity of individuals/organisations taken into account? | See section 7.0 Keele Ethical Requirement |

# Appendix 2.2: Systematic Literature Review protocol

# A quality assessment framework for knowledge management software: Systematic Literature Review protocol

By
Wijendra Gunathilake
PhD Student
School of Computing and Mathematics
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UK

**Change records**

| Document history | |
|---|---|
| Version 1.0 | First draft of protocol |
| Version 2.0 | SLR Protocol |
| | |

## 1. Background

Knowledge is considered as an asset and it contributes to the advancement of every citizen. Knowledge Management (KM) can be viewed as a socio-technical system of tacit and explicit business policies and practices. There are many definitions of KM. According to Rosemary et.al. (2002) a common thread among the plethora of definitions of KM is that its objective is to identify and leverage the collective knowledge in an organisation to help organisations compete and survive. KM is enabled by the integration of information technology tools, business processes, human or social capital, continuous learning and innovations (Halawi et.al. 2005). Knowledge Management Systems (KMS) provide benefits to organisations to implement mechanisms for collaboration, organisational learning, workflow management, intellectual property management, and document management. In implementing the mechanisms for managing knowledge, Information Technology (IT) can be used as an enabler in this era of knowledge economy. One obvious use of IT to enable KM is through e-Learning: the creation and distribution of knowledge through the online delivery of information, communication, education, and training (Rosemary et.al.2002). KMSS (KMSS) is a component of KMS that can be used as a platform for managing various forms of knowledge in organisations.

Learning is one of the important aspects that will be facilitated through KMS. There are different learning theories and definitions of learning. In this research I would like to use a more extended definition:

> *"Learning is any experience or event whose outcome (whether or not intended) develops or changes people's knowledge, skills, values or behaviour" (Harrison, 2000)*

The Effectiveness of any system is measured by considering how it satisfies the quality dimensions. It is evident that the usefulness of KMS and its successful application derive from the quality of its various components (Rao et.al. 2007). For the effectiveness of learning, quality of the KMS is a key parameter. Therefore, it is important to identify the quality dimensions in KMS environment for effectiveness of learning. Mohammad (2010) has proposed a framework for quality in KMS consisting of eight dimensions consisting of functionality, completeness, reliability, usability, access, serviceability, flexibility and security. Rao et.al. (2007), grouped the quality dimensions of KMS into ontology dimensions, knowledge item dimensions, knowledge retainer dimensions and knowledge usage dimensions. Knowledge retainer dimensions have been further subdivided into codified knowledge retainers and personalised knowledge retainers.

In order to evaluate learning effectiveness in using knowledge management software a systematically designed quality assessment framework plays a vital role. Theories of learning provide a basis for identifying quality attributes that should be evaluated in knowledge management software environment. Lim (2007) identified eight contributors towards learning effectiveness as motivation, self-efficacy, contents of training, face-to-face meeting, e-mail exchange, ease of use, seniors' support, and continuous learning culture. The different aspects of effective learning when used in knowledge management software should be analysed in order to gain the potential benefits of KM.

To our knowledge, most of the studies are focused on software quality rather than learning effectiveness and there is not much research carried out by making special emphasis on learning effectiveness and quality assessment of KMS particularly on KMSS and e-Learning environments. In this research quality attributes identified by considering the learning effectiveness and software quality will be evaluated through an identified architecture. The main objective of this study is to find out the various approaches to quality assessment in KMS with a view to establishing a quality assessment framework for knowledge management software. In order to achieve this objective, the research will be carried out in stages identified as systematic literature review into KMS, detailed study of tools for KM, designing a framework for a quality assessment framework and evaluating the effectiveness of the proposed framework.

Through the literature review it is evident that there are common features of e-Learning and KM. According to Rosemary et.al. (2002) KM and e-Learning are both about knowledge generation (acquisition, creation, capture, and adoption), knowledge storage, knowledge distribution, and knowledge application. In short, e-Learning permits participants to acquire knowledge, pass it from one person to another, apply it to organisational problems/opportunities, and store that knowledge for future use. In relating e-Learning to KM it is evident that (e-) Learning is cognitively a part of knowledge sharing and therefore part of KM (Peter *et.al.* 2002). Thus quality assessment can be considered as a key parameter for learning effectiveness in KM as well as e- learning. In developing the research questions for this SLR protocol these common features in assessing the quality of both e-Learning and KM are taken in to account.

In the process of literature review, the Systematic Literature Review (SLR) method as explained in (Kitchenham and Charters, 2007b) will be used to identify related work in KMS and investigate how it will apply to this research. There are many reasons for undertaking a SLR. As stated in (Kitchenham and Charters, 2007b) the most common reasons are to summarise the existing evidence concerning a treatment or technology (e.g. to summarise the empirical evidence of the benefits and limitations of a specific agile method), to identify any gaps in current research in order to suggest areas for further investigation and to provide a framework/background in order to appropriately position new research activities.

The SLR protocol for this research specifies the research questions, search strategy, inclusion, exclusion and quality criteria, data extraction, and methods of synthesis. The objectives of this SLR are to undertake a systematic review of the literature related to KM, to select a sub-set of studies related to KMS and KMSS, to collect and analyse the evidence from these studies in order to assess the need for quality assessment framework for knowledge management software, to identify the existing tools and mechanisms for assessing the quality in knowledge management software and to identify an appropriate methodology for carrying out the proposed research.

Based on the general structure of SLRs, the protocol for this study has been organised as follows:

Section 01: Change Records
Section 02: Introduction
Section 03: Research Questions
Section 04: Search Strategy
Section 05: Selection Criteria
Section 06: Data Extraction
Section 07: Synthesis
Section 08: Study Limitations
Section 09: Validation of the Protocol
Section 10: Dissemination Strategy
Section 11: Schedule

**2. Research questions**

The aim of this study is to find out the various approaches to quality assessment in KMS with a view to leveraging a quality assessment framework for knowledge management software. The research questions identified or conducting SLR of this research are given below.

RQ1: What topics are being investigated by researchers on Knowledge Management Systems (KMS) or e-Learning Systems?

RQ2: What is quality in KMS or e-Learning Systems?

RQ3: What are the quality attributes of a KMS or e-Learning software?

RQ4: What are the methods of assessing quality in KMS or e-Learning software?

RQ5: How is learning effectiveness measured in KMS or e-Learning systems?

**3. Search strategy**

The search strategy for this study aims at identifying and collecting all of the literature that complies with inclusion and exclusion criteria. Automatic searches and manual searches including electronic databases and conference proceedings will be used to collect the most relevant literature and to avoid the bias in publication media. The search process and results will be documented as they occur and changes to the search process will be noted and justified. The year of publication will not be considered as a restriction for search. The inclusion and exclusion criteria explained in section 4 will be used to extract the related publications.

The large number of references that will be collected during the SLR will be kept in a database created using EndNote software. The reference of each paper that satisfies the inclusion criteria will be entered into another database in EndNote software along with the

DOI (Digital Object Identifier). A copy of the abstract and a justification detailing why the paper has been accepted will be kept for each paper selected. The unfiltered search results will be saved and retained for possible secondary analysis. Details that will be documented during the search process are given in Table 1.

| Data Source | Documentation |
|---|---|
| Digital Library | Name of database<br>Search strategy for the database<br>Date of search<br>Years covered by search |
| Journal Hand Searches | Name of journal<br>Years searched<br>Any issues not searched |
| Conference proceedings | Title of proceedings<br>Name of conference (if different)<br>Title translation (if necessary)<br>Journal name (if published as part of a journal) |
| Other sources | Date Searched/Contacted<br>URL<br>Any specific conditions pertaining to the search |

Table 1 Details of search results

### 3.1 Search strings

The following search strings have been devised and will be used to search on all the electronic resources. The text strings are identified by considering the research questions in order to identify as many relevant publications as possible. The search strings that will be used for each research question is shown in Table 02. The full text search will be run on the resources mentioned in section 3.2.

| RQ | Search Strings |
|---|---|
| RQ1: What topics are being investigated by researchers on Knowledge Management Systems (KMS) or e-Learning Systems? | ((((“knowledge” OR “learning”) AND “management”) OR “KM” OR “e-Learning” OR “on line learning”) AND (“system” OR “systems”) OR “LMS” OR “KMS”) |
| RQ2: What is quality in KMS or e-Learning Systems? | ((“quality” AND (((“knowledge” OR “learning”) AND “management”) OR “e-Learning”) AND (“system” OR “systems” OR “software”)) OR “ KMS” OR “LMS”)) |
| RQ3: What are the quality attributes of a KMS or e-Learning software? | ((“quality” AND (“attributes” OR “factors”)) AND ((“knowledge” OR “learning”) AND “management”) OR “KM” OR “e-Learning”) AND |

| | |
|---|---|
| | (“system” OR “systems” OR “software”) OR “LMS” OR “KMS”) |
| RQ4: What are the methods of assessing quality in KMS or e-Learning software? | (“method” OR “methods” OR “way” OR “ways” OR “ technique” OR “techniques OR “measure” OR “measures”) AND (“assess” OR “assessing”) AND “quality” AND ( ((“knowledge” OR “learning”) AND “management”) OR “KM”OR e-Learning) AND (“system” OR “systems” OR “software”) OR “ KMS” OR “LMS”) |
| RQ5: How is learning effectiveness measured in KMS or e-Learning systems? | (“on line learning” OR “e-Learning” OR “learning management system” OR “Learning Management Systems” OR “knowledge management system” OR “Knowledge Management Systems” OR “KMS” OR “LMS”) AND (“quality” OR “learning effectiveness” OR “assessment” OR “evaluation”) |

Table 2 Search strings for research questions

### 3.2 Digital resources

The resources that will be searched include electronic databases, conference proceedings, journals and other sources such as reference lists in selected publications. The electronic databases that will be used for this search are ScienceDirect, EBSCOhost, ACM Digital Library, ISI Web of Knowledge and Springerlink. Reference lists in selected publications will be manually examined to identify the most related publications that were not discovered during the initial search. At a later stage some of the relevant journals will be consulted in order to identify the publications which are related to this research.

## 4. Selection criteria

The selection criteria in the SLR the specify criteria for inclusion and exclusion of publications for the selected list of publications. The criteria explained below have been identified in order to extract all the relevant literature and to eliminate the inclusion of publications which are not acceptable for SLR.

### 4.1 Inclusion criteria

- Date of publication will not act as a barrier for inclusion
- Where several papers have reported the same study only the most recent paper will be included
- Relevant technical papers will be accepted if publicly accessible
- Publications on quality assessment on KMS as well as e-Learning environments will be included

### 4.2 Exclusion criteria

- Publications will be excluded if the main focus is not related to the research questions
- Other articles such as unpublished reports, letters and editorials, prefaces, article summaries, interviews, news, reviews, correspondence, discussions, comments, readers' letters and summaries of tutorials, workshops, panels, and poster sessions will be excluded.
- Papers written in languages other than English will be excluded

**4.3 Selection process**

The consistency of the inclusion and exclusion criteria will be tested and verified systematically in the search process by adopting the method explained in this section. The selection process will be carried out by the researcher and verified using retest method within a time period of one month. A random sample of the archived search results will be selected by the two PhD supervisors and will be compared with the results of the searches obtained by the researcher. The selection process will be carried out in two phases: initially using the title, abstract, keyword and secondly using the full text review. Publications found during the initial search will be assessed for their suitability based upon analysis of their title and abstract. Clearly irrelevant literature according to the exclusion criteria will be excluded.

Figure 1 shows the stages of the systematic review process used in this SLR. The number of publications identified at each stage will be used for checking the validity based on inclusion criteria. In the first stage the titles, abstracts, and keywords of the articles in the electronic databases mentioned in section 3.2 will be searched using the search strings mentioned in section 3.1. At the second stage, publications will be excluded based on titles. The final selected list of publications will be selected after reading the abstracts at the third stage.

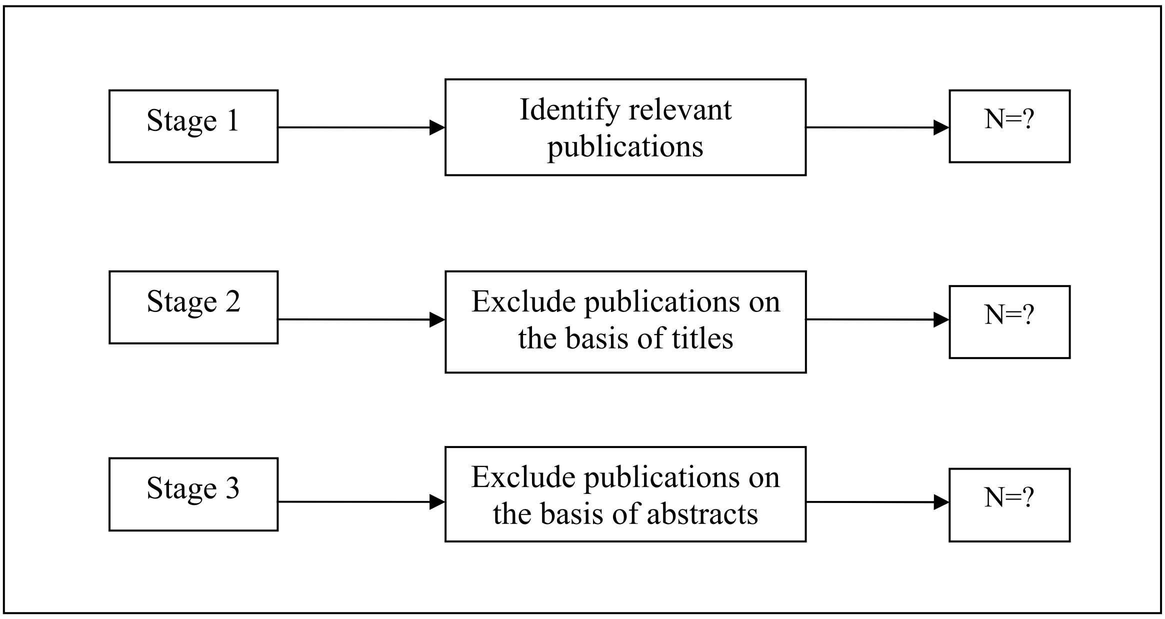


Figure 1 Stages of the selection process

### 4.4 Validation of the search strings

During the proposal development stage of this research several papers that were identified as being relevant to this study are mentioned below.

1. Adela Lau, Eric Tsui (2009), Knowledge management perspective on e-Learning effectiveness ,*Knowledge-Based Systems*, *Volume 22, Issue 4*, *May 2009*, *Pages 324-325*
2. Wang, Y. M. and Y. S. Wang (2009). Examining the dimensionality and measurement of user-perceived knowledge and information quality in the KMS context. Journal of Information Science 35(1): 94-109.
3. Rao, L. and K.-M. Osei-Bryson (2007). Towards defining dimensions of knowledge systems quality. Expert Systems with Applications 33(2): 368-378

These papers were returned from the trial searches run on digital libraries chosen for this SLR. Search strings and the returned result is shown in Appendix C. Inclusiveness of the search strings selected has been validated and the same search strings were run on the chosen digital libraries as mentioned in section 3.2 in order to collect the publications relevant to this study.

## 5. Quality assessment

This section explains the quality assessment procedure used to assure that the selected set of publications will provide valuable collection of facts for the SLR. The quality assessment of each publication selected for the final set will be carried out at the same time of extraction. The quality assessment criteria used in Dyba˚ and Dingsøyr (2008) is selected since they have been comprehensively explained the quality assessment for different types of research articles to be extracted for SLR. The 11 criteria covered three main issues pertaining to quality that will need to be considered when appraising the studies identified in the review (see Appendix A):

Rigour: Has a thorough and appropriate approach been applied to key research methods in the study?

Credibility: Are the findings well-presented and meaningful?

Relevance: How useful are the findings to the software industry and the research community?

Taken together, these 11 criteria provided a measure of the extent to which we could be confident that a particular study's findings could make a valuable contribution to the review. A summary of the quality assessment criteria for selecting publications is presented in Table 3.

| Number | Criteria |
|---|---|
| 1 | Is the paper based on research (or is it merely a ‘‘lessons learned” report based on expert opinion)? |
| 2 | Is there a clear statement of the aims of the research? |
| 3 | Is there an adequate description of the context in which the research was carried out? |
| 4 | Was the research design appropriate to address the aims of the research? |
| 5 | Was the recruitment strategy appropriate to the aims of the research? |
| 6 | Was there a control group with which to compare treatments? |
| 7 | Was the data collected in a way that addressed the research issue? |
| 8 | Was the data analysis sufficiently rigorous? |
| 9 | Has the relationship between researcher and participants been considered to an adequate degree? |
| 10 | Is there a clear statement of findings? |
| 11 | Is the study of value for research or practice? |

Table 3 Quality assessment criteria

The first two criteria will be used to assess for minimum quality criteria that will exclude non research papers and those that do not clearly state the aims of their research. The remaining nine criteria will be used to determine the rigour and credibility of the research methods employed in the selected papers as well as the relevance of each paper to be included to SLR. The answer to each question, in regard to each item of literature included in the SLR will be tabulated using a value range 1 (Yes), 0.5 (May Be), or 0 (No). The most useful papers will be judged and the validity will be tested by a second and third researcher in addition to the main researcher.

**6. Data extraction**

The data to be extracted from each article will be entered by using the data extraction form shown in Appendix B. All data will be extracted by the author and the validity will be checked by the second reviewer by selecting a random sample. The anomalies of the results obtained by different reviewers will be resolved after comparison with the original set of data collected with the intervention of the third reviewer in consensus meetings, so that inter-researcher consistency can be assessed. The publications will be read in full to extract the information given in Appendix B. Including multiple publications of the same data in this systematic review synthesis will be avoided, because duplicate reports would seriously bias the results. When necessary the authors will contacted to confirm whether or not reports refer to the same study. When there are duplicate publications, the most recent one will be used. If information is available from studies in progress, it will be included providing appropriate quality information about the study and written permission will be obtained from the researchers. Authors will be contacted to obtain the required information if the reports do not include all relevant data or poorly written and ambiguous. Sometimes primary studies do not provide all the data but it is possible to recreate the required data by manipulating the published data. If any such manipulations are required, data will first be reported in the way they were reported. Sensitivity analysis will be used to include data obtained by manipulation.

## 7. Synthesis

The aim of the data synthesis strategy used in this SLR protocol is to collate and summarise the results of the studies included for the SLR. The data synthesis strategy will be summarised after aggregating the results of the SLR. However, extracted information about the studies (i.e. intervention, population, context, sample sizes, outcomes, and study quality) will be tabulated in a manner consistent with the research questions. Tables will be structured to highlight similarities and differences between study outcomes. The purpose of tabulating in this manner is to identify whether results from studies are consistent with one another (i.e. homogeneous) or inconsistent (e.g. heterogeneous). Results will be tabulated to display the impact of potential sources of heterogeneity, e.g. study type, study quality, and sample size. Based on the tabulated results, a narrative summary of the findings of the studies will be written. Before the synthesis process is adopted, validity of the synthesis process will be tested by using the results.

## 8. Study limitations

A major limitation in carrying out this SLR is the lack of control in the use of electronic databases to collect a large proportion of publications. As the results from these databases will be returned automatically for selected search strings, little influence can be exerted over what is returned by them. This will lead to returning search results which are not identical. Several measures will be taken to minimise these limitations. One of such measures will be to carry out pilot testing of the protocol and sampling of results by other reviewers (two PhD supervisors) other than the main researcher (the author).

## 9. Validation of the protocol

Before conducting the SLR, the SLR protocol will be validated by the author and expert reviewers at Keele University. The changes identified by the author and suggested by the reviewers will be incorporated into the final protocol and used as the final version.

## 10. Dissemination strategy

The final phase of this SLR involves writing up the results of the review and circulating the results to potentially interested parties. Results of the SLR will be documented as a chapter on literature review in the PhD thesis of the author. In addition to this, findings of the SLR will be disseminated as a seminar for interested parties at the School of Computing and Mathematics, Keele University and presented as a journal/conference article.

## 11. Schedule

The schedule for this SLR will be prepared by considering the major activities of the SLR process identified in this SLR protocol. Sub activities for each activity will be identified in order to produce deliverables on scheduled times. Table 04 shows the schedule of activities in the SLR process.

| Time Schedule | Time (Weeks) | Activity | Deliverables | Remarks |
|---|---|---|---|---|
| 08/12/2010-31/01/2011 | 1-2 | Develop SLR Protocol | Draft Protocol | Give to Experts for review |
| 31/01/2011-07/02/2011 | 3 | Revise SLR Protocol | Final version of Protocol | Obtain feedback from |
| 07/02/2011-21/02/2011 | 4-5 | Pilot Test of Protocol | Results of Plot Test | Use Tested Protocol |
| 21/02/2011-14/03/2011 | 6-8 | Search for publications | List of Publications | |
| 14/03/2011-28/03/2011 | 9-10 | Test/Re-test process | Test Results | |
| 28/03/2011-18/04/2011 | 11-14 | Selection of Publications | Tables of Data | |
| 18/04/2011-02/05/2011 | 15-16 | Data Extraction | Results of Data Extraction | |
| 02/05/2011-16/05/2011 | 17-18 | Data Analysis | Results of Data Analysis | |
| 16/05/2011-13/06/2011 | 19-22 | Report Writing | SLR Report | Give to review by experts |
| 13/06/2011-04/07/2011 | 23-25 | Revise the report & prepare a presentation | Revised SLR Report & Presentation | |
| 04/07/2011-08/07/2011 | 26-27 | Present the results of SLR | Presentation | Feedback for presentation |

Table 4 Schedule of activities in SLR

## References


1. Dyba˚.T., Dingsøyr .T., (2008) ,Empirical studies of agile software development: A systematic review, *Inform. Softw. Technol.*
2. Harrison, R. (2000). *Employee development.* (Second ed.) London: Chartered Institute of Personnel and Development.
3. Halawi L, Aronson J and McCarthy R (2005) "Resource-Based View of Knowledge Management for Competitive Advantage" The Electronic Journal of Knowledge Management Volume 3 Issue 2, pp 75-86, available online at www.ejkm.com
4. Kitchenham B.A.et.al (2007), Guidelines for performing Systematic Literature Reviews in Software Engineering ,Version 2.3 EBSE Technical Report
5. Lim, H.L. (2007), "Validating e-Learning factors affecting training effectiveness", Information Management, Vol. 27, pp. 22-35.
6. Mohammad Saleh Owlia (2010) A framework for quality dimensions of knowledge management systems, Total Quality Management & Business Excellence, Volume 21, Issue 11 November , pages 1215 – 1228
7. Peter Donker, Lilia Efimova, Janine Swaak, (2002), Knowledge Management and (e)Learning available online at

https://doc.telin.nl/dscgi/ds.py/Get/File22667/Deliverable_1.3_v2.21.doc viewed on 24/01/2011

8. Rao L., and Kweku-Muata Osei-Bryson (2007), Towards defining dimensions of knowledge systems quality, Expert Systems with Applications,Volume 33, Issue 2, August 2007, Pages 368-378
9. Rosemary H. W., Kenneth A. G., Tanya D. ,(2002) A framework for e-Learning as a tool for knowledge management, Industrial Management & Data Systems, Volume: 102

**Appendix A**

| | |
|---|---|
| **1. Is this a research paper?**<br><br>*Consider:*<br><br>*–Is the paper based on research (or is it merely a "lessons learned" report based on expert opinion?* | □ Yes □ No |
| **2. Is there a clear statement of the aims of the research?**<br><br>*Consider:*<br><br>*–Is there a rationale for why the study was undertaken?*<br><br>*–Is the study's focus or main focus on quality assessment of KM S?*<br><br>*–Does the study present empirical data?*<br><br>*–Is there a clear statement of the study's primary outcome* | □ Yes □ No |
| **3. Is there an adequate description of the context in which the research was carried out?**<br><br>*Consider whether the researcher has identified:*<br><br>*–The industry in which results are used (e.g. education, banking, telecommunications, health care etc)* | □ Yes □ No |
| **Research design**<br><br>4. Was the research design appropriate to address the aims of the research?<br><br>*Consider:*<br><br>*– Has the researcher justified the research design (e.g. have they discussed how they decided which methods to use)?* | □ Yes □ No |
| **Sampling**<br><br>5. Was the recruitment strategy appropriate to the aims of the | |

| | |
|---|---|
| research?<br><br>*Consider:*<br><br>*–Has the researcher explained how the participants or cases were identified and selected?*<br><br>*–Are the cases defined and described precisely?*<br><br>*–Were the cases representative of a defined population?*<br><br>*–Have the researchers explained why the participants or cases they selected were the most appropriate to provide access to the type of knowledge sought by the study?*<br><br>*–Was the sample size sufficiently large?* | □ Yes □ No |
| **Control group**<br><br>6. Was there a control group with which to compare treatments?<br><br>*Consider:*<br><br>*–How were the controls selected?*<br><br>*–Were they representative of a defined population?*<br><br>*–Was there anything special about the controls?*<br><br>*–Was the non-response high? Could non-respondents be different in any way?* | □ Yes □ No |
| **Data collection**<br><br>7. Was the data collected in a way that addressed the research issue?<br><br>*Consider:*<br><br>*–Were all measures clearly defined (e.g. unit and counting rules)?*<br><br>*–Is it clear how data was collected (e.g. semi-structured interviews, focus group etc.)?*<br><br>*–Has the researcher justified the methods that were chosen?*<br><br>*–Has the researcher made the methods explicit (e.g. is there an indication of how interviews were conducted, did they use an interview guide)?*<br><br>*–If the methods were modified during the study, has the researcher explained how and why?*<br><br>*–Whether the form of the data is clear (e.g. tape recording, video material, notes etc.)*<br><br>*–Whether quality control methods were used to ensure completeness* | □ Yes □ No |

| | |
|---|---|
| *and accuracy of data collection* | |
| **Data analysis**<br><br>8. Was the data analysis sufficiently rigorous?<br><br>*Consider:*<br><br>*–Was there an in-depth description of the analysis process?*<br><br>*–If thematic analysis was used, is it clear how the categories/ themes were derived from the data?*<br><br>*–Has sufficient data been presented to support the findings?*<br><br>*–To what extent has contradictory data been taken into account?*<br><br>*–Whether quality control methods were used to verify the results* | ☐ Yes ☐ No |
| **Reflexivity (research partnership relations/recognition of researcher bias)**<br><br>9. Has the relationship between researcher and participants been considered adequately?<br><br>*Consider:*<br><br>*–Did the researcher critically examine their own role, potential bias and influence during the formulation of research questions, sample recruitment, data collection, and analysis and selection of data for presentation?*<br><br>*–How the researcher responded to events during the study and whether they considered the implications of any changes in the research design.* | ☐ Yes ☐ No |
| **Findings**<br><br>10. Is there a clear statement of findings?<br><br>*Consider:*<br><br>*–Are the findings explicit (e.g. magnitude of effect)?*<br><br>*–Has an adequate discussion of the evidence, both for and against the researcher's arguments been demonstrated?*<br><br>*–Has the researcher discussed the credibility of their findings (e.g. triangulation, respondent validation, more than one analyst)?*<br><br>*–Are limitations of the study discussed explicitly?*<br><br>*–Are the findings discussed in relation to the original research* | ☐ Yes ☐ No |

| | |
|---|---|
| *questions?*<br><br>*–Are the conclusions justified by the results?* | |
| **Value of the research**<br><br>11. Is the study of value for research or practice?<br><br>*Consider:*<br><br>*–Does the researcher discuss the contribution the study makes to existing knowledge or understanding (e.g. do they consider the findings in relation to current practice or relevant research-based literature)?*<br><br>*–Does the research identify new areas in which research is necessary?*<br><br>*–Does the researcher discuss whether or how the findings can be transferred to other populations, or consider other ways in which the research can be used?* | □ Yes □ No |

**Appendix B**

| **Study description** | | |
|---|---|---|
| 1. | Study identifier | Unique id for the study |
| 2. | Date of data extraction | |
| 3. | Bibliographic reference | Author, year, title, source |
| 4. | Type of article | Journal article, conference paper, workshop paper, book section |
| 5. | Study aims | What were the aims of the study? |
| 6. | Objectives | What were the objectives? |
| 7. | Design of study | Qualitative, quantitative (experiment, survey, case study, action research) |
| 8. | Research hypothesis | Statement of hypotheses, if any |
| 9. | Definition of Knowledge Management given in study | Verbatim from the study |
| 10. | Sample description | Size, students, professionals (age, education, experience) |
| 11. | Setting of study | Industry, in-house/supplier, products and processes used |
| 12. | Control group | Yes, no (number of groups, sample size) |
| 13. | Data collection | How was the data obtained? (questionnaires, interviews, forms) |
| 14. | Data analysis | How was the data analysed? (qualitative, |

| | | |
|---|---|---|
| | | quantitative) |
| **Study findings** | | |
| 1. | Findings and conclusions | What were the findings and conclusions? (verbatim from the study) |
| 2. | Validity | Limitations, threats to validity |
| 3. | Relevance | Research, practice |

**Appendix C**

**Validation of Search Strings**

Database:Sciencedirect:

Search String for RQ5:

(KEYWORDS ("on line learning") OR KEYWORDS ("e-Learning") OR KEYWORDS ("learning management system") OR KEYWORDS ("learning management systems") OR KEYWORDS ("knowledge management system") OR KEYWORDS ("knowledge management systems") OR KEYWORDS ("KMS") OR KEYWORDS ("LMS")) AND (KEYWORDS ("quality") OR KEYWORDS ("learning effectiveness") OR KEYWORDS ("“assessment”") OR KEYWORDS ("“evaluation”")) AND LIMIT-TO(contenttype, "1,2","Journal") AND LIMIT-TO(topics, "student,knowledge-based system,expert system,knowledge management,lms,quality assurance,blended learning,decision support,e-Learning system,formative assessment,information system,peer assessment,perceived usefulness,project management,qualitative reasoning,quality management,support system,performance evaluation")

Result:

Knowledge management perspective on e-Learning effectiveness *Knowledge-Based Systems*, *Volume 22, Issue 4*, *May 2009*, *Pages 324-325* Adela Lau, Eric Tsui

Search String for RQ2:

(TITLE-ABSTR-KEY("quality") and ((TITLE-ABSTR-KEY( "knowledge") or TITLE-ABSTR-KEY( "learning"))and TITLE-ABSTR-KEY( "management") or TITLE-ABSTR-KEY( "e-Learning")) and (TITLE-ABSTR-KEY( "system") or TITLE-ABSTR-KEY( "systems")or TITLE-ABSTR-KEY( "software")) or TITLE-ABSTR-KEY( "LMS")or TITLE-ABSTR-KEY( "KMS"))

Result:

Wang, Y. M. and Y. S. Wang (2009). "Examining the dimensionality and measurement of user-perceived knowledge and information quality in the KMS context." Journal of Information Science 35(1): 94-109.

Database: Ebscohost

Search String for RQ1:

Boolean/Phrase: AB ((((“knowledge” OR “learning”) AND “management”) OR “KM” OR “e-Learning” OR “on line learning”) AND (“system” OR “systems”) OR “KMS” OR “LMS)

Rao, L. and K.-M. Osei-Bryson (2007). "Towards defining dimensions of knowledge systems quality." Expert Systems with Applications 33(2): 368-378.

# Appendix 2.3: Application of Goal Question Metric (GQM) approach

| | Quality Attribute | Brief Description | Goal | Questions | Metric |
|---|---|---|---|---|---|
| | **Content quality (How good the learning content of the KMSS)** | | | | |
| 1 | Content representation | Representation of the content from basics with relevant examples to easily understand. | Evaluate the representation of content in knowledge management software | A1, A2 | Avg. frequency of responses to questions A1 and A2 |
| 2 | Consistency | Maintaining the consistency of the tutorial using colours, images, animations, navigation, tabs, words and phrases used in the tutorial | Evaluate the consistency of content in knowledge management software | A5 | Avg. frequency of responses to question A5 |
| 3 | Flexibility | Ability to follow the tutorial on the user's pace with interactive features and different entry and exit points in the tutorial | Evaluate the flexibility of tutorial content in knowledge management software | A3 | Avg. frequency of responses to question A3 |
| 4 | Interactive content | Interactive features of the tutorial (e.g. using video, audio, animations, text and hands on practice) | Evaluate the interactivity of the content in knowledge management software | A3 | Avg. frequency of responses to question A3 |
| 5 | Learning model | Using constructive learning model for achieving intended learning outcomes (ILOs) of the tutorial through teaching and learning activities (TLAs) and assessment tasks (ATs) | Evaluate the learning model for achieving learning outcomes in a given tutorial in knowledge management software | A1, A2, A5 | Avg. frequency of responses to questions A1, A2 and A5 |
| 6 | Clarity | Clear explanation of the tutorial, quizzes and practice tests (e.g. with instructions for self-learning, using simple examples, demonstrations, narrations and additional resource to understand the tutorial clearly) | Evaluate the clarity of the tutorials in knowledge management software | A1, A6 | Avg. frequency of responses to questions A1 and A6 |

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| 7 | Understandability | Step by step explanation of the tutorial from basics to hands on practice with demonstration for each concept explained. Use of activities (e.g. summary, quizzes and try it yourself practice questions) at the end of each section given to assure that the learner understand each section. | Evaluate the understandability of the tutorials in knowledge management software | A2 | Avg. frequency of responses to question A2 |
| 8 | Tutorial structure | Structured tutorial according to the principles of experiential learning style and constructive alignment by giving teaching and learning activities (TLAs) and Assessment Tasks (ATs) to achieve intended learning outcomes (ILOs). | Evaluate the structure of the tutorial for achieving learning outcomes of a tutorial given in knowledge management software | A2 | Avg. frequency of responses to question A2 |
| 9 | Up-to-datedness | Up to date content, examples, version of software and objects in the content | Evaluate the up- to-datedness of a tutorial in knowledge management software | A4 | Avg. frequency of responses to question A4 |
| 10 | Learner assessment quality | Quality of the quizzes and tests used for assessing learner. e.g. quizzes with different question types at the end of each section and at the end of entire tutorial, practical exercises and review of answers to quizzes and practical | Evaluate the quality of learner assessment methods used in knowledge management software | A9, A14 | Avg. frequency of responses to questions B9 and A14 |
| 11 | Well-organised | Well organised tutorial in a way that can be followed easily for completing the entre tutorial | Evaluate how well the is organised in knowledge management software | A1, A2, A5 | Avg. frequency of responses to questions A1,A2 and A5 |
| 12 | Completeness | Complete information for learning from basics to applying the knowledge gained | Evaluate the level of completeness of the information in a tutorial in | A7 | Avg. frequency of responses to question A7 |

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| | | | knowledge management software | | |
| 13 | Relevancy | Information relevant to learning outcomes as well as using the tutorial | Evaluate the relevancy of the information given in the tutorial in knowledge management software | A8 | Avg. frequency of responses to question A8 |
| 14 | Accuracy | Accuracy of the contents in the tutorial and the features to know that the tutorial is accurate. (e.g. results to MySQL statements, answers to quizzes and further references) | Evaluate the accuracy of a tutorial in knowledge management software | A8 | Avg. frequency of responses to question A8 |
| 15 | Teaching and learning | Features in the tutorial for learner centred self-learning | Evaluate the teaching and learning methods used in a tutorial in knowledge management software | A10 | Avg. frequency of responses to question A10 |
| 16 | Reliability | Reliable content for achieving the stated learning outcomes by giving easy to follow tutorial, relevant and accurate content and features to assess the knowledge gained. | Evaluate the reliability of the content in a tutorial in knowledge management software | A1, A2, A8 | Avg. frequency of responses to questions A1, A2 and A8 |
| 17 | Information contextual quality | Explanation of the tutorial using suitable examples and giving appropriate questions in quizzes to revise the tutorial. | Evaluate the context of content in a tutorial in knowledge management software | A1, A2, A6 | Avg. frequency of responses to questions A1, A2 and A6 |
| 18 | Self-regulated learning | Features in the tutorial for self-learning (e.g. clear instructions for using the tutorial with interactive content) | Evaluate the features for self-regulated learning using a tutorial in knowledge management software | A11 | Avg. frequency of responses to question A11 |

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| 19 | Usefulness | Features in the tutorial to apply the knowledge gained and to gain new experience to motivate self-learning using knowledge management software. | Evaluate the usefulness of a tutorial in knowledge management software | A12 | Avg. frequency of responses to question A12 |
| 20 | Academic performance | Achieving good academic performance after learning the tutorial (e.g. higher score for quizzes and practical test). | Evaluate the academic performance of a learner after learning a tutorial in knowledge management software | A13 | Avg. frequency of responses to question A13 |
| | **KMSS Platform quality (How good the KMSS is in terms of its operational characteristics)** | | | | |
| 21 | Easy to use | Features in the KMSS to use easily and with friendly user interface | Evaluate how easy to use knowledge management software platform | B1, B2, B5, B6 | Avg. frequency of responses to questions B1,B2,B5 and B6 |
| 22 | Security | Error free KMSS (e.g. for user log in, e-mail, opening a new page, downloading a file, etc.) | Evaluate the security of knowledge management software platform | B3 | Avg. frequency of responses to question B3 |
| 23 | Reliability | Reliable platform with features for security of users' data | Evaluate the reliability of knowledge management software platform | B3 | Avg. frequency of responses to question B3 |
| 24 | Usability | Easy to use and secure platform that facilitate to improve user's learning | Evaluate how knowledge management software is usable for learning | B1, B2, B12, C6 | Avg. frequency of responses to questions B1, B2, B12, C6 |
| 25 | Help option available | Availability of a help option in order to use the platform with minimum learning time | Evaluate the usefulness of help provided | B5 | Avg. frequency of responses to question B5 |
| 26 | User friendly | User friendliness of the graphical user interface of knowledge management software | Evaluate the user friendliness of knowledge management software | B6 | Avg. frequency of responses to question B6 |
| 27 | Well-organised | Well organised platform for users to find the required information easily | Evaluate how well the component are organised | B1, B2 | Avg. frequency of responses to questions |

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| | | | in knowledge management software | | B1 and B2 |
| 28 | Availability | Availability to access the platform during the session via internet | Evaluate the availability to access knowledge management software | B7, B8 | Avg. frequency of responses to questions B7 and B8 |
| 29 | Personalisation | Providing personalised information relevant to users ( e.g. personal profiles, scheduled activities, reminders, discussions, e-mails and messages etc. | Evaluate the personalisation feature of knowledge management software | B9 | Avg. frequency of responses to question B9 |
| 30 | Interactivity | Interactivity of the platform through its features (e.g. multimedia tools, wiki, blogs, search, discussion forum etc) | Evaluate the interactivity of knowledge management software | B10 | Avg. frequency of responses to question B10 |
| 31 | Accessibility | Accessibility of the components of the system to the users' under given privileges (e.g. links, files, audio and video etc.) | Evaluate the accessibility of components in knowledge management software | B11 | Avg. frequency of responses to question B11 |
| 32 | Response time | Providing quick responses to users (e.g. for log in, e-mail, opening a new page, downloading a file, etc.) | Evaluate the response time of knowledge management software | B4 | Avg. frequency of responses to question B4 |
| 33 | Easy to communicate | Features of the platform to communication easily through e-mail, discussion boards, social media and instant messaging | Evaluate the ease of communication using knowledge management software | C4 | Avg. frequency of responses to question C4 |
| | **User Satisfaction (Overall user satisfaction in using KMSS)** | | | | |
| 34 | Efficiency and effectiveness | Features of the KMSS for managing learner's study time (due to platform quality and content quality features) | Evaluate the efficiency and effectiveness of knowledge management software | C1, C5, C8 | Avg. frequency of responses to questions C1, C5 and C8 |
| 35 | Intention to use | Features of the KMSS to improve the intention to use (due to platform | Evaluate the Learner's intention to use | C1, C7, C8 | Avg. frequency of responses to questions |

| | | | | | |
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| | | quality and content quality features) | knowledge management software | | C1, C7, C8 |
| 36 | Learner attitudes towards KMSS | Features in the KMSS to improve learners (due to platform quality and content quality features) | Evaluate the learner's attitude towards KMSS | C1, C2, C3, C7, C8 | Avg. frequency of responses to questions C1, C2, C3, C7 and C8 |
| 37 | Enjoyable experience | Features in for gaining enjoyable experience in using the KMSS (due to platform quality and content quality features) | Evaluate how enjoyable the experience gained by using a KMSS | C7 | Avg. frequency of responses to question C7 |
| 38 | Learners' study habits (e.g. self-learning) | Providing facilities for gaining knowledge through self-regulated learning | Evaluate how well knowledge management software facilitate the learner's study habits | A11 | Avg. frequency of responses to question A11 |
| 39 | Motivation/commitment/self esteem | Ability of the KMSS to motivate learners (due to platform quality and content quality features) | Evaluate the ability of knowledge management software to raise motivation/commitment /self-esteem of a learner | C6 | Avg. frequency of responses to question C6 |
| 40 | Communication with fellow learners | Features in the KMSS to communicate using different methods (explained in platform quality attribute: easy to communicate) | Evaluate the features in knowledge management software to communicate with fellow learners | C4 | Avg. frequency of responses to question C4 |
| 41 | Time management/time on task | Features in the KMSS to effectively manage learner's study time | Evaluate the features of knowledge management software for learner's time management/time on task | C5 | Avg. frequency of responses to question C5 |

# Appendix 2.4: Questionnaire for the quality evaluation of knowledge management software

**A quality assessment framework for knowledge management software**

In the following questions, please rate the main features of the KMSS. (These questions are not about the features of MySQL)

***Instructions:***

Please tick on score for questions in sections A, B, and C

Score: 1-Strongly Agree 2-Agree 3-Neutral 4-Disagree 5-Strongly Disagree

| Q. No. | Question | Score | | | | |
|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** |
| **Section A: Content quality (How good the learning content of the KMSS)** | | | | | | |
| A1 | The learning outcomes of the tutorial are stated clearly | | | | | |
| A2 | The tutorial is easy to follow | | | | | |
| A3 | The tutorial is interactive (e.g. learning using video, audio, animations and simulations etc.) | | | | | |
| A4 | The tutorial content is up-to-date (e.g. content, examples, MySQL version, and references) | | | | | |
| A5 | Consistent colours, images, tabs, words and phrases are used in the tutorial | | | | | |
| A6 | The tutorial is explained clearly with simple examples | | | | | |
| A7 | Complete information related to learning outcomes is provided | | | | | |
| A8 | Relevant and accurate information is given in the tutorial | | | | | |
| A9 | Quizzes, practice questions and test are clearly explained | | | | | |
| A10 | Learning style is helpful to understand the learning content | | | | | |
| A11 | The tutorial is useful for self-learning | | | | | |
| A12 | The tutorial provided me with useful knowledge | | | | | |
| A13 | Evaluation methods (quizzes and test) are useful and improve my academic performance | | | | | |
| A14 | Grading structure for the test is appropriate | | | | | |
| **Section B: Platform quality (How good the KMSS is in terms of its operational characteristics)** | | | | | | |
| B1 | The KMSS is easy to use | | | | | |
| B2 | I can find the required information easily | | | | | |
| B3 | I have not encountered any system errors (e.g. for log in, e-mail, opening a new page, downloading a file, etc.) | | | | | |
| B4 | Quick responses are provided by the system (e.g. for log in, e-mail, opening a new page, downloading a file, etc.) | | | | | |
| B5 | The help provided in the system is easily accessible and useful | | | | | |
| B6 | Graphical user interface of the KMSS is user friendly | | | | | |
| B7 | The KMSS is easily accessible via Internet | | | | | |
| B8 | The KMSS is accessible at any time during the session | | | | | |
| B9 | Personalised pages in the KMSS are useful (e.g. scheduled activities, reminders, discussions, e-mails and messages etc.) | | | | | |
| B10 | Learning from the KMSS is interactive (e.g. using video, audio, blogs, wikis and discussions etc.) | | | | | |
| B11 | All the components of the system (e.g. links, files, audio and video etc.) are accessible | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| B12 | KMSS is a good educational platform that improves my learning | | | | | |
| **Section C: User satisfaction (Overall user satisfaction in using KMSS)** | | | | | | |
| C1 | The KMSS is a very efficient and effective educational tool | | | | | |
| C2 | The KMSS helped me to become more familiar with the module | | | | | |
| C3 | The KMSS will improve my academic performance in the module | | | | | |
| C4 | The KMSS makes the communication with fellow learners easier | | | | | |
| C5 | The KMSS will help to manage my study time effectively | | | | | |
| C6 | Using the KMSS has made me motivated to learn the module | | | | | |
| C7 | I enjoyed attending the KMSS session overall | | | | | |
| C8 | Overall, I am satisfied with the KMSS | | | | | |
| | | | | | | |
| | Your most preferred three features of KMSS | | | | | |
| | 1 ------------------------- | | | | | |
| | 2 ------------------------- | | | | | |
| | 3 ------------------------- | | | | | |
| | Any other features that you would like to have in KMSS | | | | | |
| | 1 ------------------------- | | | | | |
| | 2 ------------------------- | | | | | |
| | 3 ------------------------- | | | | | |
| | Any other comments about your experience using the KMSS | | | | | |
| | ------------------------------------------------------------------------------------- ------------------------------------------------------------------------------------- ------------------------------------------------------------------------------------- | | | | | |
| | | | | | | |

Thank you for participating in this survey!

# Appendix 2.5: Invitation e-mail for data collection

Dear Students,

I am a PhD student in the School of Computing and Mathematics. As a part of my research I have developed a prototype of Knowledge Management System Software (KMSS). I invite you to participate for a session on testing the quality features of this prototype. You will be given learning activities in the KMSS and a questionnaire to rate the features of the KMSS.

**You will be given a £ 5.00 book voucher as a reward for your participation.**

More Information about my research can be found from the link given below.
http://www.teach.cs.keele.ac.uk/cs/red97/Software_Evaluation.doc

**Please attend one of the sessions at Knuth Lab (CR 113), School of Computing and Mathematics.**

- **1.00 pm on Wednesday, 14th May 2014**
- **11.00 am on Thursday, 15th May 2014**
- **1.00 pm on Friday, 16th May 2014**

**If you are not available at any of these times but would still like to participate please e-mail your availability.**

Please send your willingness to participate in these sessions by sending an e-mail to:
w.gunathilake@keele.ac.uk

Participation on this exercise is completely voluntary but I would really appreciate your participation.

Thank you for your help.

Wijendra Gunathilake

My contact details:
Wijendra Gunathilake
PhD Student,
School of Computing and Mathematics
Colin Reeves Building
Keele University
Staffordshire
ST5 5BG
E-mail: w.gunathilake@keele.ac.uk
Tel: 01782 734899

Contact details for the Research Governance Officer at Keele University (if you do not wish to contact the researcher directly):
Nicola Leighton
Research Governance Officer
Research & Enterprise Services
Dorothy Hodgkin Building
Keele University
ST5 5BG
E-mail: n.leighton@uso.keele.ac.uk
Tel: 01782 733306

# Appendix 2.6: Approved ethical review application and supporting documents

1. **Ethical Approval Letter**

13th May 2013

Wijendra Gunthilake
School of Computing and Mathematics
Colin Reeves Building
Keele University

Dear Wijendra,

**RESEARCH AND ENTERPRISE SERVICES**

**Re: 'Assessment of Quality Features for Knowledge Management Software'**

Thank you for submitting your application for review.

I am pleased to inform you that your application has been approved by the Ethics Review Panel. The following documents have been reviewed and approved by the panel as follows:

| Document | Version | Date |
|---|---|---|
| Application Form | 2 | May 2013 |
| Summary of Proposal | 2 | 04/03/13 |
| Information Sheet | 5 | 13/05/13 |
| Consent Form | 5 | 13/05/13 |
| Consent Form for use of quotes | 5 | 13/05/13 |
| Questionnaire | 2 | 04/03/13 |

If the fieldwork goes beyond the date stated in your application 31st October 2013 you must notify the Ethical Review Panel via the ERP administrator at uso.erps@keele.ac.uk stating ERP2 in the subject line of the e-mail.

If there are any other amendments to your study you must submit an 'application to amend study' form to the ERP administrator stating ERP2 in the subject line of the e-mail. This form is available via http://www.keele.ac.uk/researchsupport/researchethics/

Research and Enterprise Services, Keele University, Staffordshire, ST5 5BG, UK Telephone: + 44 (0)1782 734466 Fax: + 44 (0)1782 733740

**RESEARCH AND ENTERPRISE SERVICES**

If you have any queries, please do not hesitate to contact me via the ERP administrator on uso.erps@keele.ac.uk stating ERP2 in the subject line of the e-mail.

Yours sincerely

**Dr Bernadette Bartlam**
**Chair – Ethical Review Panel**

CC RI Manager
Supervisor

2. **ERP Application**

Keele University

**ETHICAL REVIEW PANEL**

**Application Form (Staff and PGR Students)**

- To be completed for every research project involving human participants/subjects;
- The form must be authorised by your Research Institute Director / (or for applicants who are members of RI Social Sciences the application can be signed off by your Research Centre Head)/Supervisor /Head of School as appropriate
- Both an electronic copy & hard copy of all documentation must be provided.

**APPROVAL MUST BE OBTAINED BEFORE** potential participants are approached to take part in any research.

**Information regarding the completion of the ethical review panel application form:**

**Section A** – To be completed by all applicants.

**Section B** – To be completed by applicants who have already obtained Ethics Approval from a separate committee.

**Section C** – To be completed by applicants requiring approval from a University Ethical Review Panel

**Section D** – To be completed by all applicants.

*Further information regarding the completion of the application can be found in Section E (at the end of this document)*

**SECTION A (to be completed by all applicants)**

| | |
|---|---|
| Project Title: | Assessment of Quality Features for Knowledge Management Software |
| Proposed start date: | 07/01/2013 (PhD project started on 08/11/2010) |
| Proposed end date for 'field work' (eg interviews): | 31/10/2013 |
| Name of Researcher (applicant): | Habaragamu Ralalage **Wijendra** Peiris Gunathilake |
| Status: | POSTGRADUATE RESEARCH STUDENT |
| Keele Email address: | w.gunathilake@keele.ac.uk |
| Correspondence address: | School of Computing and Mathematics, Keele University, Keele, Staffordshire ST5 5BG |
| Keele Telephone number: | (0)1782 734899 |

**SECTION B (to be completed by applicants who have already obtained ethics approval from a separate committee)**

| | | |
|---|---|---|
| **Has your project already been approved by an ethics committee? (for example, an NHS research ethics committee)**<br>If **YES** the following documentation should be sent directly to the Chair of the University Research Ethics Committee, C/O Nicola Leighton, University Research Ethics Committee Administrator, Research & Enterprise Services, Dorothy Hodgkin Building, e-mail n.leighton@keele.ac.uk, telephone 01782 733306 | | NO<br>(pls delete as appropriate) |
| A completed and signed hard copy of this application form (please complete Sections A, B and D) and an electronic copy should also be e-mailed to n.leighton@keele.ac.uk | Signed hard copy: | YES<br>(pls delete as appropriate) |
| | Electronic copy: | YES<br>(pls delete as appropriate) |
| Evidence of prior ethics approval from the hosting institution. | Copy of approval document: | NO<br>(pls delete as appropriate) |

**SECTION C (to be completed by applicants who have NOT already obtained ethics approval from a separate committee)**

<table>
<tr><td colspan="3">If your project requires approval by a University Ethical Review Panel (ERP).<br><br>The following documentation should be forwarded to Nicola Leighton, Research & Enterprise Services, Dorothy Hodgkin Building, telephone 01782 733306. An electronic copy of the application form and all necessary documentation should also be e-mailed to uso.erps@keele.ac.uk An application cannot be considered until a signed copy is received and accompanied by an electronic copy.</td></tr>
<tr><td>A completed and signed hard copy of this application form (please complete Sections A, C and D) and an electronic copy should also be e-mailed to uso.erps@keele.ac.uk</td><td>Signed copy attached:<br><br>Electronic copy:</td><td>YES<br><br>YES</td></tr>
<tr><td colspan="2">A hard copy of the summarised project proposal attached to this form, NO MORE THAN two sides of A4<br><br>It may help the review of your project if you include a diagram to clearly explain the project (eg what activities will undertaken, by whom and when)<br><br>An electronic copy of the summarised project proposal<br><br>Please ensure that the version number and date is clearly stated in footer of the proposal (approval may be delayed if these details are not included)</td><td>YES<br><br>YES</td></tr>
<tr><td colspan="3">And, if they are applicable given the study’s design and approaches;</td></tr>
<tr><td colspan="2">A letter of invitation for participants<br><br>Please ensure that the version number and date is clearly stated in the footer of the letter (approval may be delayed if these details are not included)</td><td>NO<br><br>(delete as appropriate)</td></tr>
<tr><td colspan="2">An information sheet which should normally include following sections:<br><br>o Why the participant has been chosen;<br>o What will happen to participants if they take part<br>o A discussion of the possible disadvantages, risks and benefits of taking part<br>o The procedures for ensuring confidentially and anonymity (if appropriate)<br>o The proposed use of the research findings<br>o Contact details of the principal investigator plus details of additional support agencies (if Necessary)</td><td>YES<br><br>(delete as appropriate)</td></tr>
</table>

| | |
|---|---|
| o **Version number and date is clearly stated in the footer of the information sheet (approval may be delayed if these details are not included)**<br>A template for a participant information sheet is available from the Research & Enterprise Services website via the following link<br><br>http://www.keele.ac.uk/researchsupport/researchgovernance/researchethics/ | |
| A copy of the participant consent form/s;<br><br>**Please ensure that the version number and date is clearly stated in the footer of the consent form (approval may be delayed if these details are not included)**<br><br>Templates for consent forms are available from the Research & Enterprise Services website via the following link http://www.keele.ac.uk/researchsupport/researchgovernance/researchethics/ | YES<br><br>(delete as appropriate) |
| Copies of any questionnaire, interview schedules or topic guides.<br><br>**Please ensure that the version number and date is clearly stated in the footer of these documents (approval may be delayed if these details are not included)** | YES (delete as appropriate) |

**(PARTICIPANTS' CONSENTS)**

| | |
|---|---|
| **1. Will the researchers inform participants of all aspects of the research that might reasonably be expected to influence willingness to participate and in particular, any negative consequences that might occur?**<br><br>**If YES**, please give details: Participation is voluntary, but participants will be encouraged to take part and experience a new way of learning and gain new knowledge. No any negative consequences.<br><br>**If NO**, please explain:<br><br>**2. Will all participants be provided with a written information sheet and be provided with an opportunity to provide (or withhold) written consent?**<br><br>**If YES**, please ensure that these documents are attached (see above).<br><br>**If NO**, please explain why written consent &/or information is not appropriate for this study.<br><br>**3. Is consent being sought for the dataset collected to be used for future research projects?**<br><br>**4. What are the exclusion/inclusion criteria for this study (i.e. who will be allowed to / not allowed to participate)?**<br><br>Computer-literate students who are not experts in the chosen topic (Database Management Systems) are allowed to participate for this study.<br><br>Exclusion criteria: those who are computer illiterate and those who are experts in the chosen topic.<br><br>**5. Please explain briefly (and in 'lay' terms) why you plan to use these particular criteria?**<br><br>Purpose of this data collection is to evaluate the quality features of Knowledge Management software in relation to learning and applying new skills. The data collected from the participants will be used to test the acquisition and application of knowledge. Therefore participants should not be experts in the chosen topic. The published results based on the data collected will be anonymous. | YES (delete as appropriate)<br><br>YES (delete as appropriate)<br><br>NO<br><br>(delete as appropriate) |

| | |
|---|---|
| **6. Will people who are vulnerable be allowed to take part in this study?** For these purposes, vulnerable participants are those whose abilities to protect their own interests are impaired or reduced in comparison to the population as a whole. Vulnerability may arise from personal characteristics (such as mental or physical impairment) or from social context and disadvantage (e.g. lack of power, education, or resources). Prospective participants, who are at high risk of consenting under duress, or as a result of manipulation or coercion, should also be considered as vulnerable. All children and adults who lack mental capacity are presumed to be vulnerable.<br><br>**If NO**, please outline the rationale for excluding them:<br><br>Assuming that participants (our current undergraduate students in the school of Computing and Mathematics) are not in the vulnerable category.<br><br>Exclusion criteria : those who are computer illiterate and those who are experts in Database Management Systems<br><br>**If YES**, what special arrangements (if any) are in place to protect vulnerable participants' interests? | NO<br><br>(delete as appropriate) |
| 7. **Does the research activity proposed require a CRB disclosure?** (Information concerning activities which require CRB checks are required can be accessed via http://www.crb.homoffice.gov.uk and http://www.keele.ac.uk/hr/policiesprocedures/crb/ If you are unsure whether a CRB disclosure is required please Human Resources prior to submission of this application form. If you answer YES please complete the relevant section below. If you answer no please go to question 8. | NO<br><br>(delete as appropriate) |
| **STAFF ONLY**<br>**7a** Have you (and other individuals who will be working on the research project) had a CRB disclosure initiated by Keele University?<br><br>7b If you have answered **YES to question 7a** please contact Human Resources to obtain a confirmation note indicating that a CRB disclosure has been previously initiated by Keele and that it was satisfactory. The confirmation note is attached to this form.<br><br>If you have answered **NO to question 7a** please contact Human Resources immediately to arrange for a CRB disclosure to be applied for. You will still be able to apply for ethical approval in parallel to applying for a CRB disclosure. However, your project will not be approved by the ERP until you have forwarded the confirmation note from Human Resources indicating that CRB disclosure has been undertaken and is satisfactory. Human Resources have been contacted and a CRB disclosure has been initiated. | NO (delete as appropriate)<br><br>YES / NO (delete as appropriate) |

| | |
|---|---|
| **HOME/EU STUDENTS ONLY**<br>7c Have you (and other individuals who will be working on the research project) had a CRB Disclosure (or equivalent) initiated by Keele University?<br><br>7d If you have answered **YES to question 7c** please contact the Home/EU Admissions Officer to obtain a confirmation note indicating that a CRB disclosure (or equivalent) has been previously initiated by Keele and that it was satisfactory. The confirmation note is attached to this form.<br><br>If you have answered **NO to question 7c** please contact the Home/EU Admissions Office immediately to arrange for a CRB disclosure (or equivalent) to be applied for. You will still be able to apply for ethical approval in parallel to applying for a CRB disclosure. However, your project will not be approved by the ERP until you have forwarded the confirmation note from Human Resources indicating that CRB disclosure has been undertaken and is satisfactory. I confirm the Home/EU Admissions Officer has been contacted and a CRB disclosure (or equivalent) has been initiated.<br><br>**INTERNATIONALSTUDENTS ONLY**<br>Please contact Nicola Leighton on 01782 733306 or e-mail n.leighton@keele.ac.uk before completing this section<br><br>7e Have you (and other individuals who will be working on the research project) had a CRB Disclosure (or equivalent) initiated by Keele University?<br><br>7f If you have answered **YES to question 7e** please contact the appropriate person (as advised by Nicola Leighton) to obtain a confirmation note indicating that a CRB disclosure (or equivalent) has been previously initiated by Keele and that it was satisfactory. The confirmation note is attached to this form.<br><br>If you have answered **NO to question 7e** please contact the appropriate person (as advised by Nicola Leighton) immediately to arrange for a CRB disclosure (or equivalent) to be applied for. You will still be able to apply for ethical approval in parallel to applying for a CRB disclosure. However, your project will not be approved by the ERP until you have forwarded the confirmation note from Human Resources indicating that CRB disclosure has been undertaken and is satisfactory. I confirm the relevant person has been contacted and a CRB disclosure (or equivalent) has been initiated. | YES / NO (delete as appropriate)<br><br>YES / NO (delete as appropriate)<br><br>YES / NO (delete as appropriate)<br><br>YES / NO (delete as appropriate)<br><br>YES / NO (delete as appropriate)<br><br>YES / NO (delete as appropriate) |
| **8. Will the study involve participants who are unable to give valid (informed) consent (e.g. children and adults lacking mental capacity)?** | NO<br><br>(delete as appropriate) |

| | |
|---|---|
| **If YES**, what procedures will be in place to ensure that informed consent is obtained, where appropriate, from third parties (e.g. parents or carers)? And what procedures will be in place (if any) to give the participants an opportunity to have their objections recognised and respected? | |
| **9. Does the investigation involve observing participants unawares?**<br><br>**If YES**, what efforts will be made to respect their privacy, values and psychological well-being? | NO<br><br>(delete as appropriate) |
| **10. Will the confidentiality of participants be maintained?**<br><br>**If NOT**, please give rationale:<br><br>**If YES**, how? Data collected will be used only by the research team (Wijendra: PhD student, Dr Thomas Neligwa and Dr Theocharis Kyriacou: supervisors) of this research, stored securely and will not be given to any other party. The published results will be anonymised. | YES (delete as appropriate) |
| **11. Will participants require any support to take part in the research (eg. disability support, interpreter)?**<br><br>**If YES**, what sort of support is required and how will it be delivered? | NO<br><br>(delete as appropriate) |

**(PROCEDURES)**

| | |
|---|---|
| **12. Does the research involve people being investigated for a problem which has received medical, psychiatric, clinical psychological or similar attention?**<br><br>**If YES**, please give details: | NO<br><br>(delete as appropriate) |
| **13. Are drugs, placebos or other substances (eg food substances, vitamins) to be administered to participants or will the study involve invasive, intrusive or potentially harmful procedures of any kind?**<br><br>**If YES**, please give details and justify: | NO<br><br>(delete as appropriate) |
| **14. Will blood or other bodily fluids/tissues (including hair, nails and sebum) be obtained from participants?**<br><br>**If YES**, please give details and justify: | NO<br><br>(delete as appropriate) |
| **15. Is pain or more than mild discomfort likely to result from the study?**<br><br>**If YES**, please give details and justify: | NO<br><br>(delete as appropriate) |

**(RESEARCH PROCESS)**

| | |
|---|---|
| **16. Will participants receive any reimbursements or other payments**<br><br>**If YES**, please give details: | NO<br><br>(delete as appropriate) |
| **17. Does the research involve the analysis of data participants will not realise would be used by you for research purposes (e.g. confidential criminal, medical or financial records)?**<br><br>**If YES**, please give rationale: | NO<br><br>(delete as appropriate) |
| **18. Does the research involve the possible disclosure of confidential information to other participants** (e.g. in focus groups)?<br><br>**If YES**, please explain how this will be handled: | NO<br><br>(delete as appropriate) |
| **19. Will the researchers de-brief participants to ensure that they understand the nature of the research and monitor possible misconceptions or negative effects?**<br><br>**IF YES**, how will this be done? Written Instructions for completing tasks on Knowledge Management software will be given. After using the system, a questionnaire with instruction to complete will be given. As detailed in Information sheet<br><br>**If NO**, please explain why not: | YES<br><br>(delete as appropriate) |
| **20. Are there any <u>other</u> ethical issues that you think might be raised by the research?**<br><br>**If YES**, please give details: | NO<br><br>(delete as appropriate) |

**(Health & Safety)**

| | |
|---|---|
| **21. Does the project have any health & safety implications for the researcher?**<br><br>**If YES**, please outline the arrangements which are in place to manage these risks: | NO<br><br>(delete as appropriate) |
| **FOR STAFF ONLY**<br><br>**22. Does your research involve travel overseas?**<br><br>**If YES,**<br><br>Have you consulted the Foreign and Commonwealth Office website for guidance/travel advice?<br><br>http://www.fco.gov.uk/en/travel-and-living-abroad/<br><br>Have you completed and submitted the risk assessment form? Available from http://www.keele.ac.uk/finance/insurance/travelinsurance/travellingoverseas-policyriskassessment/ | YES / NO<br><br>(delete as appropriate)<br><br>YES / NO<br><br>(delete as appropriate)<br><br>YES / NO<br><br>(delete as appropriate) |
| **FOR STUDENTS ONLY**<br><br>**23. Will any research take place outside the UK?**<br><br>**If YES**<br><br>**For home students** - have you consulted the Foreign and Commonwealth Office website for guidance/travel advice? http://www.fco.gov.uk/en/travel-and-living-abroad/<br><br>**For international students - h**ave you also sought advice/guidance from the Foreign Office (or equivalent body) of your country?<br><br>**For all students -** will you be visiting any areas for which particular risks have been identified or for which the advice given is not to travel to this area?<br><br>**If YES** | NO<br><br>(delete as appropriate)<br><br>YES / NO<br><br>(delete as appropriate)<br><br>YES / NO<br><br>(delete as appropriate) |

| | |
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| (a) Please give details<br><br><br>(b) Please outline the arrangements in place to manage these risks. | YES / NO<br><br>(delete as appropriate) |
| **24. What insurance arrangements are in place?** (Please contact Alan Slater on 01782 733525 to ascertain if you will be covered by University Insurance) | University Insurance / Personal Insurance<br><br>(delete as appropriate) |

**SECTION D (to be completed by all applicants)**

Please complete the checklist below to indicate the version number and date of any supporting documents included with this application.

| Document(s) | Version Number | Date |
|---|---|---|
| **Summary Proposal** | **02** | **04/03/2013** |
| **Letter of Invitation(s)** | | |
| **Information Sheet(s)** | **03** | **03/05/2013** |
| **Consent Form(s)** | **03** | **03/05/2013** |
| **Consent Form(s) for use of quotes** | **02** | **03/05/2013** |
| **Questionnaire(s)** | **02** | **04/03/2013** |
| **Interview Topic Guide(s)** | | |
| | | |
| | | |
| | | |

| **Signatures** | **Signatures** |
|---|---|
| **Principal Investigator / Research Student:**<br><br>I understand that I must comply with the University's regulations and other applicable codes of ethics at all times. | **Research Institute Director / (or for applicants who are members of RI Social Sciences the application can be signed off by your Research Centre Head) / Supervisor / Head of** |

<table>
<tr>
<td>

HRpGunathilake

…………………………………………

**~~Principal Investigator /~~ Research Student***

03/05/2013

…………………..

Date

*please delete as appropriate

</td>
<td>

**School**

I have read this application and confirm that:-

- The academic and/or scientific quality of the application is satisfactory.
- Arrangements are in place for the management and governance of this project

………………………………………
……………………………..

**~~Research Institute Director / Research Centre Head /~~ Supervisor / ~~Head of School *~~**

…………………………

Date

*please delete as appropriate

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**Please ensure when submitting your proposal that you have provided a hard copy and e-mailed a copy of all the documentation to the relevant administrator:-**

**Applicants who have already obtained ethics approval from a separate committee** should forward documentation to

Nicola Leighton, University Research Ethics Committee Administrator, Research & Enterprise Services, Dorothy Hodgkin Building, e-mail n.leighton@keele.ac.uk, telephone 01782 733306.

**Applications which require approval by an University Ethical Review Panel** should forward documentation to Nicola Leighton, Research & Enterprise Services, Dorothy Hodgkin Building, e-mail uso.erps@keele.ac.uk, telephone 01782 733306.

Please note that it is your responsibility to follow the University's Code of good research practice http://www.keele.ac.uk/researchsupport/researchgovernance/ and any relevant academic or professional guidelines in the conduct of your study. **This includes providing appropriate information sheets and consent forms, and ensuring confidentiality in the**

**storage and use of data.** Any significant change in the question, design or conduct over the course of the research should be notified to the Research Institute Director/Supervisor and may require a new application for ethics approval.

This form was developed from the Ethics application forms used within Humanities and Social Sciences with kind permission from the HUMSS Research Ethics Committee.

## SECTION E

**Information regarding the completion of the ethical review panel application form**

Section A – To be completed by all applicants.

Section B – To be completed by applicants who have already obtained Ethics Approval from a separate committee.

Section C – To be completed by applicants requiring approval from a University Ethical Review Panel

Section D – To be completed by all applicants.

**PLEASE NOTE: Ethics Approval for Research Projects**

All projects involving human research participants/subjects and/or data about identifiable individuals, need to be approved by an ethics committee before the fieldwork for projects can commence. The University has established Ethical Review Panels to review proposed research projects to be undertaken by staff and postgraduate research students. The information below provides more details about the role of these panels and the documents that need to be submitted to support the review process.

1. If your project has already been approved by a recognised ethics committee (for example, an NHS research ethics committee), the following documentation should be sent directly to the Chair of the University Research Ethics Committee, C/o Nicola Leighton, University Research Ethics Committee Administrator, Research & Enterprise Services, Dorothy Hodgkin Building, e-mail n.leighton@keele.ac.uk, telephone 01782 733306.

   - A completed and signed ethical review application form (Sections A, B and D) accompanied by an electronic copy;
   - Evidence of prior ethics approval from the hosting institution.

2. If your project requires approval by a University Ethical Review Panel, the following documentation should be sent directly to Nicola Leighton, Research & Enterprise Services, Dorothy Hodgkin Building, e-mail uso.erps@keele.ac.uk, telephone 01782 733306

   - A completed and signed ethical review application form (Sections A, C and D) accompanied by an electronic copy of the application form and relevant documentation. An application cannot be considered until a signed copy is received and also by an electronic copy;
   - A summarised project proposal, **NO MORE THAN** two sides of A4 paper;
     ***And, if they are applicable given the study's design and approaches,***

   - A letter of invitation for participants;
   - An information sheet which should normally include following sections: invitation paragraph; the purpose of the study; why the participant has been chosen; what will

happen to participants if they take part; a discussion of the possible disadvantages, risks and benefits of taking part; the procedures for ensuring confidentiality and anonymity, if any; the proposed use of the research findings; and contact details of the principal investigator plus details of additional support agencies (if necessary);
- A copy of the participant consent form;
- Copies of any questionnaire, interview schedules or topic guides.

3. The review will be undertaken at the next available ethical review panel meeting. Please access http://www.keele.ac.uk/researchsupport/researchgovernance/researchethics/ for a list of meeting dates and submission deadlines. Following the review process you will be informed of the panel's decision which will be either:

   - Study approved;
   - Study approved subject to clarification of issues, modification of design or provision of additional information which will be itemised in the letter of response;
   - Study rejected with supporting reasons.

4. If ethical approval is not granted, applicants have the right of appeal to the University's Research Ethics Committee.

5. Correspondence informing applicants of the outcome of the panel's decision will be copied to the relevant Research Administrators. It is the responsibility of applicants to keep their respective Institutes informed of their research activities for the purposes of research governance.

3. **Information Sheet and Consent Form**

**Information Sheet**

**Study Title**: Assessment of Quality Features for Knowledge Management Software

The objective of this research is to investigate the quality factors that impact the learning effectiveness in Knowledge Management System Software (KMSS) environment. The results of this research can be applied to KMSS initiatives in any business sector.

**Aims of the Research**

Assessing quality attributes of knowledge management software with a view to devising a quality evaluation model.

**Invitation**

You are being invited to consider taking part in the research study on "Assessment of Quality Features for Knowledge Management Software".

This project is being undertaken by Habaragamu Ralalage **Wijendra** Peiris Gunathilake (PhD student) under the supervision of Dr Thomas Neligwa (first supervisor) and Dr Theocharis Kyriacou (Second supervisor) at the School of Computing and Mathematics, Keele University.

Before you decide whether or not you wish to take part, it is important for you to understand why this research is being done and what it will involve. Please take time to read this information carefully and discuss it with friends and relatives if you wish. Ask us if there is anything that is unclear or if you would like more information.

**Why have I been chosen?**

We intend to collect views from computer-literate students who are not experts in the chosen topics in Database Management Systems (e.g. relational databases, database design and data manipulation concepts). A sample of 30 participants will be selected from students in the Undergraduate and Post Graduate Degree programmes at Keele University, who have not studied the Database Management Systems module.

You will be requested to participate this survey by a group e-mail and a poster advertisement (participation is entirely voluntary).

This study is independent of any academic programme at Keele and there is absolutely no relationship with students' performance on their programme of study.

**Do I have to take part?**

You are free to decide whether you wish to take part or not. If you do decide to take part you will be asked to sign two consent forms, one is for you to keep and the other is for our records. You are free to withdraw from this study at any time and without giving reasons.

**What will happen if I take part?**

*Explain what exactly will happen to participants (e.g. you will be given a questionnaire to complete)*

You will be required to do some computer tasks as described in the question below.

**If I take part, what do I have to do?**

*Set down briefly and clearly what you will expect of participants*

You will be informed a date and time in April- May 2013 to be available for 2 hours session in the Turing Lab at School of Computing and Mathematics. You will be given a user account in a Knowledge Management Software to use during this period. After using the system you will be given a questionnaire to be completed. The approximate time for completing the questionnaire is 20 minutes.

You will be given written instructions for tasks given on a Knowledge Management System Software (KMSS) but to perform the tasks on Database Management Software (MySQL). The tasks given are educational activities related to Database Management Systems including learning the content. After using the software a questionnaire will be given to rate the features of the software. Written semi-structured questionnaire that will be given include close ended and open ended questions. A questionnaire collection box will be placed in the lab to put your questionnaire.

**What are the benefits (if any) of taking part?**

There are no actual benefits to taking part but you will gain new knowledge about knowledge Management System Software (KMSS) and Database Management Systems.

**What are the risks (if any) of taking part?**

There are no risks in taking part on this exercise.

**How will information about me be used?**

*Explain how their data will be collected and what the data will be used for. It must be clear whether the data collected will be retained for use in future research studies and whether further ethics approval will be sought.*

The data collected through the questionnaire will be used to analyse the users' perceptions on the quality of Knowledge Management Software. This study is conducted as a part of a PhD research and therefore data will be used only for this research. After collecting data, analysed data will be published in PhD thesis, conference papers and journal articles. All published data will be anonymised.

**Who will have access to information about me?**

*You should tell the participants how their confidentiality will be safeguarded during and after the study.*

The research team (Wijendra: PhD student, Dr Thomas Neligwa and Dr Theocharis Kyriacou: supervisors) will have access to the data collected but confidentiality will be safeguarded during the study. Data will be stored securely in a password protected computer and a locked filing cabinet after the study and will be used only by the research team.

Data will be retained by the principal investigator for at least five years and they will be securely disposed.

**Who is funding and organising the research?**

This is a self funded PhD research project

**What if there is a problem?**

If you have a concern about any aspect of this study, you may wish to speak to the researcher(s) who will do their best to answer your questions. You should contact Habaragamu Ralalage **Wijendra** Peiris Gunathilake on (0)1782 734899 or w.gunathilake@keele.ac.uk. Alternatively, if you do not wish to contact the researcher(s) you may contact supervisors Dr Thomas Neligwa (t.neligwa@keele.ac.uk) and Dr Theocharis Kyriacou (t.kyriacou@keele.ac.uk).

If you remain unhappy about the research and/or wish to raise a complaint about any aspect of the way that you have been approached or treated during the course of the study please write to Nicola Leighton who is the University's contact for complaints regarding research at the following address:-

Nicola Leighton

Research Governance Officer

Research & Enterprise Services

Dorothy Hodgkin Building

Keele University

ST5 5BG

E-mail: n.leighton@uso.keele.ac.uk

Tel: 01782 733306

**Contact for further information**

Normally only Keele telephone numbers and e-mail addresses should be used in all study documentation. If there are reasons to depart from this then these must be explained in your Ethical Review Panel documentation.

**CONSENT FORM**

**Title of Project:** Assessment of Quality Features for Knowledge Management Software

**Name and contact details of Principal Investigator:**

Habaragamu Ralalage **Wijendra** Peiris Gunathilake,

School of Computing and Mathematics, Keele University, Keele, Staffordshire ST5 5BG

(0)1782 734899

w.gunathilake@keele.ac.uk

**Please tick box if you agree with the statement**

| | | |
|---|---|---|
| 1 | I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions. | ☐ |
| 2 | I understand that my participation is voluntary and that I am free to withdraw at any time. | ☐ |
| | I agree to take part in this study. | ☐ |
| 4 | I understand that data collected about me during this study will/~~will not~~* be anonymised before it is submitted for publication. | ☐ |

| | | |
|---|---|---|
| Name of participant | Date | Signature |
| Researcher | Date | Signature |

*please delete as appropriate

**CONSENT FORM**

**(for use of quotes)**

**Title of Project:** Assessment of Quality Features for Knowledge Management Software

**Name and contact details of Principal Investigator:**

Habaragamu Ralalage **Wijendra** Peiris Gunathilake,

School of Computing and Mathematics, Keele University, Keele, Staffordshire ST5 5BG

(0)1782 734899

w.gunathilake@keele.ac.uk

**Please tick box if you agree with the statement**

1 I agree for any quotes to be used ☐

2 I do not agree for any quotes to be used ☐

| | | |
|---|---|---|
| Name of participant | Date | Signature |
| Researcher | Date | Signature |

# Appendix 3.1: An example of the search strings used and refined results

**Database: Science Direct**

**RQ 1: What topics are being investigated by researchers on Knowledge Management Systems (KMS) or e-Learning Systems?**

**Search String for Title, Abstract, and Keywords Search**

((((TITLE-ABSTR-KEY(“knowledge”) or TITLE-ABSTR-KEY( “learning”)) and TITLE-ABSTR-KEY( “management”))or TITLE-ABSTR-KEY( “KM”)or TITLE-ABSTR-KEY( “e-Learning”)or TITLE-ABSTR-KEY( “on line learning”))and (TITLE-ABSTR-KEY( “system”)or TITLE-ABSTR-KEY( “systems”))or TITLE-ABSTR-KEY(“KMS”) TITLE-ABSTR-KEY(“LMS”))

**Results:**

**16,379** articles found for: ((((TITLE-ABSTR-KEY(“knowledge”) or TITLE-ABSTR-KEY( “learning”)) and TITLE-ABSTR-KEY( “management”))or TITLE-ABSTR-KEY( “KM”)or TITLE-ABSTR-KEY( “e-Learning”)or TITLE-ABSTR-KEY( “on line learning”))and (TITLE-ABSTR-KEY( “system”)or TITLE-ABSTR-KEY( “systems”))or TITLE-ABSTR-KEY(“KMS”) or TITLE-ABSTR-KEY(“LMS”))

**Search String for Keywords Search**

((((KEYWORDS(“knowledge”) or KEYWORDS ( “learning”)) and KEYWORDS ( “management”))or KEYWORDS ( “KM”)or TITLE KEYWORDS ( “e-Learning”)or KEYWORDS ( “on line learning”))and (KEYWORDS ( “system”)or KEYWORDS ( “systems”))or KEYWORDS (“KMS”) or KEYWORDS (“LMS”))

**Results:**

35 articles found for: ((((KEYWORDS(“knowledge”) or KEYWORDS ( “learning”)) and KEYWORDS ( “management”))or KEYWORDS ( “KM”)or TITLE KEYWORDS ( “e-Learning”)or KEYWORDS ( “on line learning”))and (KEYWORDS ( “system”)or KEYWORDS ( “systems”))or KEYWORDS (“KMS”) or KEYWORDS (“LMS”) ) AND LIMIT-TO(contenttype, "1,2","Journal")

**RQ2: What is quality in KMS or e-Learning Systems?**

**Search String for Title, Abstract, and Keywords Search**

(TITLE-ABSTR-KEY(“quality”) and ((TITLE-ABSTR-KEY( “knowledge”) or TITLE-ABSTR-KEY( “learning”))and TITLE-ABSTR-KEY( “management”)) and (TITLE-ABSTR-KEY( “system”) or TITLE-ABSTR-KEY( “systems”)or TITLE-ABSTR-KEY( “software”)) or TITLE-ABSTR-KEY( “KMS”) or TITLE-ABSTR-KEY( “LMS”))

**Results:**

**918** articles found for: (TITLE-ABSTR-KEY(“quality”) and ((TITLE-ABSTR-KEY( “knowledge”) or TITLE-ABSTR-KEY( “learning”))and TITLE-ABSTR-KEY( “management”) or TITLE-ABSTR-KEY( “e-Learning”)) and (TITLE-ABSTR-KEY( “system”) or TITLE-ABSTR-KEY( “systems”)or TITLE-ABSTR-KEY( “software”)) or TITLE-ABSTR-KEY( “LMS”)or TITLE-ABSTR-KEY( “KMS”))

**Search String for Keywords Search**

(KEYWORDS (“quality”) and ((KEYWORDS ( “knowledge”) or KEYWORDS ( “learning”))and KEYWORDS ( “management”) or KEYWORDS ( “e-Learning”)) and (KEYWORDS ( “system”) or KEYWORDS ( “systems”)or KEYWORDS ( “software”)) or KEYWORDS ( “LMS”) or KEYWORDS ( “KMS”))

**Results:**

**23** articles found for: (KEYWORDS (“quality”) and ((KEYWORDS ( “knowledge”) or KEYWORDS ( “learning”))and KEYWORDS ( “management”) or KEYWORDS ( “e-Learning”)) and (KEYWORDS ( “system”) or KEYWORDS ( “systems”)or KEYWORDS ( “software”)) or KEYWORDS ( “LMS”) or KEYWORDS ( “KMS”))

**RQ3: What are the quality attributes of a KMS or e-Learning software?**
**Search String for Title, Abstract, and Keywords Search**
(TITLE-ABSTR-KEY ("quality") AND (TITLE-ABSTR-KEY ("attributes") OR TITLE-ABSTR-KEY ("factors"))) AND (TITLE-ABSTR-KEY ("knowledge") OR TITLE-ABSTR-KEY ("learning")) AND TITLE-ABSTR-KEY( "management") OR TITLE-ABSTR-KEY ("KM") OR TITLE-ABSTR-KEY ("e-Learning") AND (TITLE-ABSTR-KEY ("system") OR TITLE-ABSTR-KEY ("systems") OR TITLE-ABSTR-KEY ("software")) OR TITLE-ABSTR-KEY ("LMS") OR TITLE-ABSTR-KEY ("KMS"))
**Results:**
**163** articles found for: ((TITLE-ABSTR-KEY ("quality") AND (TITLE-ABSTR-KEY ("attributes") OR TITLE-ABSTR-KEY ("factors"))) AND (TITLE-ABSTR-KEY ("knowledge") OR TITLE-ABSTR-KEY ("learning")) AND TITLE-ABSTR-KEY( "management") OR TITLE-ABSTR-KEY ("KM") OR TITLE-ABSTR-KEY ("e-Learning") AND (TITLE-ABSTR-KEY ("system") OR TITLE-ABSTR-KEY ("systems") OR TITLE-ABSTR-KEY ("software")) OR TITLE-ABSTR-KEY ("LMS") OR TITLE-ABSTR-KEY ("KMS"))
**Search String and Results for Keywords Search**
**1** articles found for: ((KEYWORDS("quality") AND (KEYWORDS("attributes") OR KEYWORDS("factors"))) AND (KEYWORDS("knowledge") OR KEYWORDS("learning")) AND KEYWORDS ( "management") OR KEYWORDS("KM") OR KEYWORDS("e-Learning") AND (KEYWORDS("system") OR KEYWORDS("systems") OR KEYWORDS("software")) OR KEYWORDS("KMS") OR KEYWORDS("LMS"))

**RQ4: What are the methods of assessing quality in KMS or e-Learning software?**
**Search String and Results for Title, Abstract, and Keywords Search**
**61** articles found for: (TITLE-ABSTR-KEY ("method") OR TITLE-ABSTR-KEY ("methods") OR TITLE-ABSTR-KEY ("way") OR TITLE-ABSTR-KEY ("ways") OR TITLE-ABSTR-KEY (" technique") OR TITLE-ABSTR-KEY ("techniques") OR TITLE-ABSTR-KEY ("measure") OR TITLE-ABSTR-KEY ( "measures")) AND (TITLE-ABSTR-KEY ("assess") OR TITLE-ABSTR-KEY ("assessing")) AND TITLE-ABSTR-KEY ( "quality") AND (((TITLE-ABSTR-KEY ("knowledge") OR TITLE-ABSTR-KEY ("learning")) AND TITLE-ABSTR-KEY ( "management")) OR TITLE-ABSTR-KEY ("KM") OR TITLE-ABSTR-KEY ("e-Learning")) AND (TITLE-ABSTR-KEY ("system") OR (TITLE-ABSTR-KEY ("systems") OR TITLE-ABSTR-KEY ( "software") ) OR TITLE-ABSTR-KEY ( " KMS") OR TITLE-ABSTR-KEY (" LMS"))
**Search String and Results for Keywords Search**
(KEYWORDS ("method") OR KEYWORDS ("methods") OR KEYWORDS ("way") OR KEYWORDS ("ways") OR KEYWORDS (" technique") OR KEYWORDS ("techniques") OR KEYWORDS ("measure") OR KEYWORDS ( "measures")) AND (KEYWORDS ("assess") OR KEYWORDS ("assessing")) AND KEYWORDS ( "quality") AND (((KEYWORDS ("knowledge") OR KEYWORDS ("learning")) AND KEYWORDS ( "management")) OR KEYWORDS ("KM") OR KEYWORDS ("e-Learning")) AND (KEYWORDS ("system") OR (KEYWORDS ("systems") OR KEYWORDS ( "software") ) OR KEYWORDS ( " KMS") OR KEYWORDS ( " LMS"))
No results found

**RQ5: How is learning effectiveness measured in KMS or e-Learning systems?**

**Search String and Results for Title, Abstract, and Keywords Search**
**3,856** articles found for: (TITLE-ABSTR-KEY ("on line learning") OR TITLE-ABSTR-KEY ("e-Learning") OR TITLE-ABSTR-KEY ("learning management system") OR TITLE-ABSTR-KEY ("learning management systems") OR TITLE-ABSTR-KEY ("knowledge management system") OR TITLE-ABSTR-KEY ("knowledge management systems") OR TITLE-ABSTR-KEY ("KMS") OR TITLE-ABSTR-KEY ("LMS")) AND (TITLE-ABSTR-KEY ("quality") OR TITLE-ABSTR-KEY ("learning effectiveness") OR TITLE-ABSTR-KEY ("“assessment”") OR TITLE-ABSTR-KEY ("“evaluation”"))
**Search String and Results for Keywords Search**
**138** articles found for: (KEYWORDS ("on line learning") OR KEYWORDS ("e-Learning") OR KEYWORDS ("learning management system") OR KEYWORDS ("learning management systems") OR KEYWORDS ("knowledge management system") OR KEYWORDS ("knowledge management systems") OR KEYWORDS ("KMS") OR KEYWORDS ("LMS")) AND (KEYWORDS ("quality") OR KEYWORDS ("learning effectiveness") OR KEYWORDS ("“assessment”") OR KEYWORDS ("“evaluation”"))
**Search String and Results for Keywords Search after Refining for Subject Area**
**34** articles found for: (KEYWORDS ("on line learning") OR KEYWORDS ("e-Learning") OR KEYWORDS ("learning management system") OR KEYWORDS ("learning management systems") OR KEYWORDS ("knowledge management system") OR KEYWORDS ("knowledge management systems") OR KEYWORDS ("KMS") OR KEYWORDS ("LMS")) AND (KEYWORDS ("quality") OR KEYWORDS ("learning effectiveness") OR KEYWORDS ("“assessment”") OR KEYWORDS ("“evaluation”")) AND LIMIT-TO(contenttype, "1,2","Journal") AND LIMIT-TO(topics, "student,knowledge-based system,expert system,knowledge management,lms,quality assurance,blended learning,decision support,e-Learning system,formative assessment,information system,peer assessment,perceived usefulness,project management, qualitative reasoning, quality management,support system, performance evaluation")

**Database: ISI Web of Knowledge**

**RQ1: What topics are being investigated by researchers on Knowledge Management Systems (KMS) or e-Learning Systems?**
**Search String and Results for Title Search**
Title=("Knowledge Management System") OR Title=("Learning Management System") OR Title=("e-Learning System") OR Title=("On Line Learning") OR Title=("KMS") OR Title=("LMS") Refined by: Subject Areas=( COMPUTER SCIENCE OR EDUCATION & EDUCATIONAL RESEARCH OR INFORMATION SCIENCE & LIBRARY SCIENCE ) AND Languages=( ENGLISH ) AND Subject Areas=( COMPUTER SCIENCE OR EDUCATION & EDUCATIONAL RESEARCH OR INFORMATION SCIENCE & LIBRARY SCIENCE )
Timespan=All Years.
Results: 984

**RQ2: What is quality in KMS or e-Learning Systems?**

# 14
>100,000
Title=("Quality")

Timespan=All Years
# 16
2,961
Title=("Knowledge Management System") OR Title=("Learning Management System") OR Title=("e-Learning System") OR Title=("On Line Learning") OR Title=("KMS") OR Title=("LMS")
Timespan=All Years
# 17
22
#16 AND #14
Timespan=All Years

Results: 22

**RQ3: What are the quality attributes of a KMS or e-Learning software?**

# 16
2,961
Title=("Knowledge Management System") OR Title=("Learning Management System") OR Title=("e-Learning System") OR Title=("On Line Learning") OR Title=("KMS") OR Title=("LMS")
Timespan=All Years

Results: 1,153
Title=("Quality Attributes") OR Title=("Quality Factors")
Timespan=All Years.
1

Using AND Operator
1. Title: The role of quality factors in intention to continue using an e-Learning system in Malaysia
Author(s): Ramayah, T; Ahmad, NH; Lo, MC
Conference Information: 2nd World Conference on Educational Sciences (WCES-2010), Date: FEB 04-08, 2010 Bahceschir Univ Istanbul TURKEY
Source: INNOVATION AND CREATIVITY IN EDUCATION Volume: 2 Issue: 2 Pages: 5422-5426 Published: 2010
Times Cited: 1

**RQ4: What are the methods of assessing quality in KMS or e-Learning software?**

# 19
21
#18 AND #13
Databases=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH Timespan=All Years

# 18
10,689
Title=("Methods") OR Title=("Ways") OR Title=("Techniques") OR Title=("Measures") AND Title=("Assessing") AND Title=("Quality")
Refined by: Subject Areas=( COMPUTER SCIENCE, THEORY & METHODS OR COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE OR COMPUTER SCIENCE,

INTERDISCIPLINARY APPLICATIONS ) AND Subject Areas=( COMPUTER SCIENCE, THEORY & METHODS OR COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE OR COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS OR COMPUTER SCIENCE, INFORMATION SYSTEMS OR COMPUTER SCIENCE, SOFTWARE ENGINEERING OR COMPUTER SCIENCE, HARDWARE & ARCHITECTURE OR EDUCATION, SCIENTIFIC DISCIPLINES OR EDUCATION & EDUCATIONAL RESEARCH ) AND Document Type=( PROCEEDINGS PAPER OR ARTICLE ) AND Languages=( ENGLISH ) Databases=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH Timespan=All Years
# 13
2,952
Title=("Knowledge Management System") OR Title=("Learning Management System") OR Title=("On Line Learning") OR Title=("e-Learning") OR Title=("KMS") OR Title=("LMS") OR Title=("Knowledge Management Software")
Refined by: Subject Areas=( COMPUTER SCIENCE, INFORMATION SYSTEMS OR EDUCATION & EDUCATIONAL RESEARCH OR COMPUTER SCIENCE, THEORY & METHODS OR COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS OR COMPUTER SCIENCE, SOFTWARE ENGINEERING OR EDUCATION, SCIENTIFIC DISCIPLINES OR INFORMATION SCIENCE & LIBRARY SCIENCE ) AND Document Type=( PROCEEDINGS PAPER OR ARTICLE ) AND Languages=( ENGLISH )
Databases=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH Timespan=All Years

**RQ5: How is learning effectiveness measured in KMS or e-Learning systems?**

# 1
>100,000
Title=(quality) OR Title=("learning effectiveness") OR Title=(assessment) OR Title=(evaluation)
Databases=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH Timespan=All Years

# 7
2,768
Title=("Knowledge Management System") OR Title=("Learning Management System") OR Title=("On Line Learning") OR Title=("e-Learning") OR Title=("KMS") OR Title=("LMS")
Refined by: Document Type=( PROCEEDINGS PAPER OR ARTICLE ) AND Subject Areas=( COMPUTER SCIENCE, INFORMATION SYSTEMS OR EDUCATION & EDUCATIONAL RESEARCH OR COMPUTER SCIENCE, THEORY & METHODS OR COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS ) AND Languages=( ENGLISH ) AND Subject Areas=( COMPUTER SCIENCE, INFORMATION SYSTEMS OR EDUCATION & EDUCATIONAL RESEARCH OR COMPUTER SCIENCE, THEORY & METHODS OR COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS OR COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE OR COMPUTER SCIENCE, SOFTWARE ENGINEERING OR EDUCATION, SCIENTIFIC DISCIPLINES OR INFORMATION SCIENCE & LIBRARY SCIENCE )
Databases=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH Timespan=All Years

# 9
186
#7 AND #1

Refined by: Subject Areas=( EDUCATION & EDUCATIONAL RESEARCH OR COMPUTER SCIENCE, INFORMATION SYSTEMS OR COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS OR COMPUTER SCIENCE, THEORY & METHODS OR COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE OR EDUCATION, SCIENTIFIC DISCIPLINES OR INFORMATION SCIENCE & LIBRARY SCIENCE OR COMPUTER SCIENCE, SOFTWARE ENGINEERING )
Databases=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH Timespan=All Years

**Database: EBSCOHOST**

**RQ 1: What topics are being investigated by researchers on Knowledge Management Systems (KMS) or e-Learning Systems?**
**Search String and Results for Abstract Search**
9452 Results for...Boolean/Phrase: AB ((((“knowledge” OR “learning”) AND “management”) OR “KM” OR “e-Learning” OR “on line learning”) AND (“system” OR “systems” ) OR “KMS” OR “LMS)
Results for Key Words:31

**RQ 2 : What is quality in KMS or e-Learning Systems?**
**Search String and Results for Abstract Search**
3189 Results for...Boolean/Phrase: AB(((“quality” AND (((“knowledge” OR “learning”) AND “management”) OR “e-Learning”) AND (“system” OR “systems” OR “software”)) OR “ KMS” OR “LMS”))
Results for Key Words:54

**RQ3:What are the quality attributes of a KMSS or e-Learning software?**
**Search String and Results for Abstract Search**
4432 Results for...AB "Quality Factors" or AB "Quality Attributes" and AB "Knowledge Management Systems" or AB "e-Learning" or AB on line learning or AB "KMS" or AB "Knowledge Management Software"
Results for Key Words: 34

**RQ4: What are the methods of assessing quality in KMSS or e-Learning software?**
**Search String and Results for Abstract Search**
180 Results for... AB methods of assessing quality or AB ways of assessing quality or AB techniques of assessing quality and AB knowledge Management system or AB learning management system or AB KMS or AB LMS or AB e-Learning
Results for Key Words::21

**RQ5: How is learning effectiveness measured in KMS or e-Learning systems?**
**Search String and Results for Abstract Search**
155 Results for... AB ((“on line learning” OR “e-Learning” OR “learning management system” OR “learning management systems” OR “knowledge management system” OR “knowledge management systems” OR “KMS” OR “LMS”) AND (“quality” OR “learning effectiveness” OR “assessment” OR “evaluation”))
Results for Key Words:64

# Appendix 3.2: Results of the quality assessment of publications

| Publication no. | Criteria 1 Research | 2 Aim | 3 Context | 4 Design | 5 Recruitment | 6 Control | 7 Data Collection | 8 Data Analysis | 9 Reflexivity | 10 Findings | 11 Value | Total | File Name | Citation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | | 1 | 4 | RQ2 SD1 | Govindasamy, T., *Successful implementation of e-Learning: Pedagogical considerations.* The Internet and Higher Education, 2001. 4(3-4): p. 287-299. |
| 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | RQ2 SD2 | Baets, W., L. Brunenberg, and M. van Wezel, *Using neural network-based tools for building learning organisations.* Accounting, Management and Information Technologies, 1998. **8**(4): p. 211-226. |
| 3 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 9 | RQ2 SD3 | Wu, J.-H. and Y.-M. Wang, *Measuring KMS success: A respecification of the DeLone and McLean's model.* Information & Management, 2006. **43**(6): p. 728-739. |
| 4 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 9 | RQ2 SD4 | Fresen, J.W. and L.G. Boyd, *Caught in the web of quality.* International Journal of Educational Development, 2005. **25**(3): p. 317-331. |
| 5 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 9 | RQ2 SD5 | Alkhattabi, M., D. Neagu, and A. Cullen, *Assessing information quality of e-Learning systems: a web mining approach.* Computers in Human Behavior, 2011. **27**(2): p. 862-873. |
| 6 | 1 | 1 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | RQ2 SD6 | Gebus, S. and K. Leiviskä, *Knowledge acquisition for decision support systems on an* |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | *electronic assembly line.* Expert Systems with Applications, 2009. **36**(1): p. 93-101. |
| 7 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 9 | RQ2 SD7 | Ramayah, T., N.H. Ahmad, and M.-C. Lo, *The role of quality factors in intention to continue using an e-Learning system in Malaysia.* Procedia - Social and Behavioral Sciences, 2010. **2**(2): p. 5422-5426. |
| 8 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | RQ2 EB1 | Black, E.W., et al., The other side of the LMS: Considering implementation and use in the adoption of an LMS in online and blended learning environments. TechTrends, 2007. 51(2): p. 35-39. |
| 9 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 8 | RQ2 EB2 | Christie, M. and R.G. Jurado, *Barriers to innovation in online pedagogy.* European Journal of Engineering Education, 2009. **34**(3): p. 273-279. |
| 10 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 7 | RQ2 EB3 | Tikhomirova, N., A. Gritsenko, and A. Pechenkin, EXECUTIVE INTERVIEW: University approach to knowledge management. VINE: The Journal of Information & Knowledge Management Systems, 2008. 38(1): p. 16-21. |
| 11 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 9 | RQ2 EB4 | Adeyinka, T. and S. Mutula, A proposed model for evaluating the success of WebCT course content management system. Computers in Human Behavior, 2010. 26(6): p. 1795-1805. |
| 12 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 9 | RQ2 EB5 | Meho, L.I. and Y. Kiduk, Multi-faceted Approach to Citation-based Quality Assessment for Knowledge Management. IFLA Conference Proceedings, 2006: p. 1-14. |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 7 | RQ2 EB6 | Nevo, D., B. Furneaux, and Y. Wand, Towards an evaluation framework for knowledge management systems. Information Technology & Management, 2008. 9(4): p. 233-249. |
| 14 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 7 | RQ2 EB7 | Rao, L. and K.-M. Osei-Bryson, Towards defining dimensions of knowledge systems quality. Expert Syst. Appl., 2007. 33(2): p. 368-378. |
| 15 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 8 | RQ2 ACM 1 | Kulkarni, U., S. Ravindran, and R. Freeze, A Knowledge Management Success Model: Theoretical Development and Empirical Validation. J. Manage. Inf. Syst., 2007. 23(3): p. 309-347. |
| 16 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 6 | RQ2 ACM 2 | Lauer, T.W., Questions and Information: Contrasting Metaphors. Information Systems Frontiers, 2001. 3(1): p. 41-48. |
| 17 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 11 | RQ2 ACM 3 | Ulrich, B., L. Yuliya, and M. Sarfraz, An approach of a knowledge management system in an automated manufacturing environment, in Proceedings of the 9th WSEAS International Conference on International Conference on Automation and Information. 2008, World Scientific and Engineering Academy and Society (WSEAS): Bucharest, Romania. p. 566-569. |
| 18 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 9 | RQ2 ISI 1 | Ellis, R.A. and R.A. Calvo, Minimum indicators to assure quality of LMS-supported blended learning. Educational Technology & Society, 2007. 10(2): p. 60-70. |
| 19 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 8 | RQ2 ISI 2 | Alexander, S. and T. Golja, Using students' experiences to derive quality in an e-Learning |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | system: An institution's perspective. Educational Technology & Society, 2007. 10(2): p. 17-33. |
| 20 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 5 | RQ2 ISI 3 | Dan, B.D. and M.M. Cristian, Development of quality software for on-line learning. 2006 International Conference on Information and Technology: Research and Education, 2006: p. 217-221. |
| 21 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 9 | RQ2 ISI 4 | Darbyshire, P., On-line learning, quality and student satisfaction: A case study. Information Technology and Organizations: Trends, Issues, Challenges and Solutions, Vols 1 and 2, 2003: p. 314-317. |
| 22 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 10 | RQ2 ISI 5 | Weaver, D., C. Spratt, and C.S. Nair, Academic and student use of a learning management system: Implications for quality. Australasian Journal of Educational Technology, 2008. 24(1): p. 30-41. |
| 23 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 11 | RQ3 SD1 | Lee, J.-K. and W.-K. Lee, The relationship of e-Learner's self-regulatory efficacy and perception of e-Learning environmental quality. Computers in Human Behavior, 2008. 24(1): p. 32-47. |
| 24 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | | 1 | 9 | RQ3 SD2 | Ozkan, S. and R. Koseler, Multi-dimensional students' evaluation of e-Learning systems in the higher education context: An empirical investigation. Computers & Education, 2009. 53(4): p. 1285-1296. |
| 25 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 10 | RQ3 EB1 | Georgouli, K., I. Skalkidis, and P. Guerreiro, A Framework for Adopting LMS to Introduce e-Learning in a Traditional Course. Journal of Educational Technology & Society, 2008. |

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| | | | | | | | | | | | | | | 11(2): p. 227-240. |
| 26 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 9 | RQ4 SD1 | Nagel, L. and T.G. Kotzé, Supersizing e-Learning: What a CoI survey reveals about teaching presence in a large online class. The Internet and Higher Education, 2010. 13(1-2): p. 45-51. |
| 27 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 9 | RQ4 ISI 1 | Ounaies, H.Z., et al., Measurement framework for aligning adaptation methods with business and usage factors in e-Learning, in Imecs 2008: International Multiconference of Engineers and Computer Scientists, Vols I and Ii. 2008, Int Assoc Engineers-Iaeng: Hong Kong. p. 29-34. |
| 28 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 10 | RQ4 ISI 2 | Tsianos, N., et al., Working Memory Span and E-Learning: The Effect of Personalization Techniques on Learners' Performance, in User Modeling, Adaptation, and Personalization, Proceedings, P. DeBra, A. Kobsa, and D. Chin, Editors. 2010, Springer-Verlag Berlin: Berlin. p. 64-74. |
| 29 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 9 | RQ5 SD1 | Brew, L.S., The role of student feedback in evaluating and revising a blended learning course. The Internet and Higher Education, 2008. 11(2): p. 98-105. |
| 30 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 8 | RQ5 SD2 | Cavus, N., The evaluation of Learning Management Systems using an artificial intelligence fuzzy logic algorithm. Advances in Engineering Software, 2010. 41(2): p. 248-254 |
| 31 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 8 | RQ5 SD3 | Cavus, N. and A.a.M. Momani, Computer aided evaluation of learning management |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | systems. Procedia - Social and Behavioral Sciences, 2009. 1(1): p. 426-430. |
| 32 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 9 | RQ5 SD4 | Chang, T.-Y. and Y.-T. Chen, Cooperative learning in E-Learning: A peer assessment of student-centered using consistent fuzzy preference. Expert Systems with Applications, 2009. 36(4): p. 8342-8349. |
| 33 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 9 | RQ5 SD5 | Derntl, M. and R. Motschnig-Pitrik, The role of structure, patterns, and people in blended learning. The Internet and Higher Education, 2005. 8(2): p. 111-130. |
| 34 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 11 | RQ5 SD6 | Fernández-Breis, J.T., D. Castellanos-Nieves, and R. Valencia-García, Measuring individual learning performance in group work from a knowledge integration perspective. Information Sciences, 2009. 179(4): p. 339-354. |
| 35 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | RQ5 SD8 | Lau, A. and E. Tsui, Knowledge management perspective on e-Learning effectiveness. Knowledge-Based Systems, 2009. 22(4): p. 324-325. |
| 36 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 10 | RQ5 SD9 | Martínez, R.-A., et al., Psychopedagogical components and processes in e-Learning. Lessons from an unsuccessful on-line course. Computers in Human Behavior, 2007. 23(1): p. 146-161. |
| 37 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 6 | RQ5 SD10 | Moussa, N. and S. Moussa, Quality assurance of e-Learning in developing countries. Nonlinear Analysis: Theory, Methods & Applications, 2009. 71(12): p. e32-e34. |
| 38 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 10 | RQ5 SD11 | Paechter, M., B. Maier, and D. Macher, Students' expectations of, and experiences in |

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| | | | | | | | | | | | | | | e-Learning: Their relation to learning achievements and course satisfaction. Computers & Education, 2010. 54(1): p. 222-229. |
| 39 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 7 | RQ5 SD12 | Pond, W.K., Twenty-first century education and training: Implications for quality assurance. The Internet and Higher Education, 2001. 4(3-4): p. 185-192. |
| 40 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 10 | RQ5 SD13 | Reid, I.C., Reflections on using the Internet for the evaluation of course delivery. The Internet and Higher Education, 2001. 4(1): p. 61-75. |
| 41 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 10 | RQ5 SD14 | Teo, T., Development and validation of the E-Learning Acceptance Measure (ElAM). The Internet and Higher Education, 2010. 13(3): p. 148-152. |
| 42 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 9 | RQ5 SD15 | Wang, T.-H., Web-based quiz-game-like formative assessment: Development and evaluation. Computers & Education, 2008. 51(3): p. 1247-1263.13(3): p. 164-169. |
| 43 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 10 | RQ5 SD16 | Tseng, S.-C. and C.-C. Tsai, Taiwan college students' self-efficacy and motivation of learning in online peer assessment environments. The Internet and Higher Education, 2010. 13(3): p. 164-169. |
| 44 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 10 | RQ5 EB1 | Andersson, A. and M. Hatakka, Increasing Interactivity in Distance Educations: Case Studies Bangladesh and Sri Lanka. Information Technology for Development, 2010. 16(1): p. 16-33. |
| 45 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 9 | RQ5 EB2 | Chao, R.-J. and Y.-H. Chen, Evaluation of the criteria and effectiveness of distance e- |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | Learning with consistent fuzzy preference relations. Expert Systems with Applications, 2009. 36(7): p. 10657-10662. |
| 46 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 6 | RQ5 EB3 | Connolly, M., N. Jones, and J. O'Shea, Quality assurance and e-learning: reflections from the front line. Quality in Higher Education, 2005. 11(1): p. 59-67. |
| 47 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 9 | RQ5 EB5 | Gierlowski, K. and K. Nowicki, A Novel Architecture for E-Learning Knowledge Assessment Systems. International Journal of Distance Education Technologies, 2009. 7(2): p. 1-19. |
| 48 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 11 | RQ5 EB6 | Hong-Ren, C. and H. Hui-Ling, User Acceptance of Mobile Knowledge Management Learning System: Design and Analysis. Journal of Educational Technology & Society, 2010. 13(3): p. 70-77. |
| 49 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 9 | RQ5 EB7 | Jennex, M.E., Exploring System Use as a Measure of Knowledge Management Success. Journal of Organizational & End User Computing, 2008. 20(1): p. 50-63. |
| 50 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 9 | RQ5 EB8 | Kale, S. and B. Richardson, The effective use of e-Learning in postgraduate health-care students. International Journal of Therapy & Rehabilitation, 2006. 13(7): p. 299-302. |
| 51 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 10 | RQ5 EB9 | Kılıç-Çakmak, E., S. Karataş, and M.A. Ocak, AN ANALYSIS OF FACTORS AFFECTING COMMUNITY COLLEGE STUDENTS' EXPECTATIONS ON E-LEARNING. Quarterly Review of Distance Education, 2009. 10(4): p. 351-361. |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 52 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 11 | RQ5 EB10 | Kim, S.W. and M.G. Lee, Validation of an evaluation model for learning management systems. Journal of Computer Assisted Learning, 2008. 24(4): p. 284-294. |
| 53 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 11 | RQ5 EB11 | Lee, D. and S. Kang, Perceived Usefulness and Outcomes of Intranet-Based Learning (IBL): Developing Asynchronous Knowledge Management Systems in Organizational Settings. Journal of Instructional Psychology, 2005. 32(1): p. 68-73. |
| 54 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 10 | RQ5 EB12 | Mohayidin, M.G., et al., The Application of Knowledge Management in Enhancing the Performance of Malaysian Universities. Electronic Journal of Knowledge Management, 2007. 5(3): p. 301-312. |
| 55 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 11 | RQ5 EB13 | Poston, R.S. and C. Speier, EFFECTIVE USE OF KNOWLEDGE MANAGEMENT SYSTEMS: A PROCESS MODEL OF CONTENT RATINGS AND CREDIBILITY INDICATORS. MIS Quarterly, 2005. 29(2): p. 221-244. |
| 56 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 10 | RQ5 EB14 | Shee, D.Y. and Y.-S. Wang, Multi-criteria evaluation of the web-based e-Learning system: A methodology based on learner satisfaction and its applications. Computers & Education, 2008. 50(3): p. 894-905. |
| 57 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 11 | RQ5 EB15 | Tseng, S.-M., Knowledge management system performance measure index. Expert Systems with Applications, 2008. 34(1): p. 734-745. |
| 58 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 10 | RQ5 EB16 | Wills, G.B., et al., An e-Learning framework for assessment (FREMA). Assessment & |

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| | | | | | | | | | | | | | | Evaluation in Higher Education, 2009. 34(3): p. 273-292. |
| 59 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | RQ5 EB17 | Wurst, M., Analysis and evaluation of distributed knowledge management by agent-based simulation. International Journal of Knowledge Based Intelligent Engineering Systems, 2006. 10(4): p. 307-317. |
| 60 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 10 | RQ5 EB18 | Zhao, J., School knowledge management framework and strategies: The new perspective on teacher professional development. Computers in Human Behavior, 2010. 26(2): p. 168-175. |
| 61 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 8 | RQ5 ISI1 | Bouarab-Dahmani, F., et al., Automated Evaluation of Learners with ODALA: Application to Relational Databases E-Learning. International Journal of Computational Intelligence Systems, 2010. 3(3): p. 357-369. |
| 62 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 10 | RQ5 ISI2 | Buyukozkan, G., J. Arsenyan, and G. Ertek, Evaluation of E-Learning Web Sites Using Fuzzy Axiomatic Design Based Approach. International Journal of Computational Intelligence Systems, 2010. 3(1): p. 28-42. |
| 63 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 11 | RQ5 ISI3 | Chiu, C.M., et al., Usability, quality, value and e-Learning continuance decisions. Computers & Education, 2005. 45(4): p. 399-416. |
| 64 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 10 | RQ5 ISI4 | Concannon, F., A. Flynn, and M. Campbell, What campus-based students think about the quality and benefits of e-Learning. British Journal of Educational Technology, 2005. 36(3): p. 501-512. |

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| 65 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 7 | RQ5 ISI7 | Ehlers, U.D., Quality literacy - Competencies for quality development in education and e-Learning. Educational Technology & Society, 2007. 10(2): p. 96-108. |
| 66 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 7 | RQ5 ISI8 | Fardoun, H., F. Montero, and V.L. Jaquero, eLearniXML: Towards a model-based approach for the development of e-Learning systems considering quality. Advances in Engineering Software, 2009. 40(12): p. 1297-1305. |
| 67 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 9 | RQ5 ISI9 | Ginns, P. and R.A. Ellis, Evaluating the quality of e-Learning at the degree level in the student experience of blended learning. British Journal of Educational Technology, 2009. 40(4): p. 652-663. |
| 68 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 9 | RQ5 ISI10 | Grubisic, A., et al., Controlled experiment replication in evaluation of e-Learning system's educational influence. Computers & Education, 2009. 53(3): p. 591-602. |
| 69 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 11 | RQ5 ISI11 | Hay, D.B., et al., Measuring the quality of e-Learning. British Journal of Educational Technology, 2008. 39(6): p. 1037-1056. |
| 70 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 11 | RQ5 ISI12 | Ho, C.L. and R.J. Dzeng, Construction safety training via e-Learning: Learning effectiveness and user satisfaction. Computers & Education, 2010. 55(2): p. 858-867. |
| 71 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 11 | RQ5 ISI13 | Jara, M. and H. Mellar, Quality enhancement for e-Learning courses: The role of student feedback. Computers & Education, 2010. 54(3): p. 709-714. |
| 72 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 11 | RQ5 ISI14 | Kalyuga, S. and J. Sweller, Rapid dynamic assessment of expertise to improve the |

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| | | | | | | | | | | | | | | efficiency of adaptive e-Learning. Etr&D-Educational Technology Research and Development, 2005. 53(3): p. 83-93. |
| 73 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | RQ5 ISI15 | Mandinach, E.B., The development of effective evaluation methods for e-Learning: A concept paper and action plan. Teachers College Record, 2005. 107(8): p. 1814-1835. |
| 74 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | | 9 | RQ5 ISI16 | Oladiran, M.T. and J. Uziak, ASSESSMENT OF E-LEARNING COURSE DELIVERY FOR MECHANICAL ENGINEERING STUDENTS AT THE UNIVERSITY OF BOTSWANA. Journal of Baltic Science Education, 2009. 8(1): p. 44-53. |
| 75 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | RQ5 ISI17 | Pah, I., et al., Technology to support education software solutions for quality assurance in e-Learning. International Journal of Computers Communications & Control, 2008. 3: p. 433-436. |
| 76 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 10 | RQ5 ISI18 | Shee, D.Y. and Y.S. Wang, Multi-criteria evaluation of the web-based e-Learning system: A methodology based on learner satisfaction and its applications. Computers & Education, 2008. 50(3): p. 894-905. |
| 77 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 10 | RQ5 ISI19 | Wang, T.H., What strategies are effective for formative assessment in an e-Learning environment? Journal of Computer Assisted Learning, 2007. 23(3): p. 171-186. |
| 78 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 11 | RQ5 ISI21 | Yang, S.J.H., et al., Enhancing the quality of e-Learning in virtual learning communities by finding quality learning content and trustworthy collaborators. Educational Technology & Society, 2007. 10(2): p. 84-95. |

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| 79 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 11 | RQ5 ISI22 | Zhang, D.S., et al., Instructional video in e-Learning: Assessing the impact of interactive video on learning effectiveness. Information & Management, 2006. 43(1): p. 15-27. |
| 80 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 11 | RQ5 ISI23 | Zhang, L.X., et al., EVALUATION OF LEARNING PERFORMANCE OF E-LEARNING IN CHINA: A METHODOLOGY BASED ON CHANGE OF INTERNAL MENTAL MODEL OF LEARNERS. Turkish Online Journal of Educational Technology, 2010. 9(1): p. 70-82. |
| 81 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 11 | RQ5 SL1 | Konstantinidis, A., T. Tsiatsos, and A. Pomportsis, Collaborative virtual learning environments: design and evaluation. Multimedia Tools and Applications, 2009. 44(2): p. 279-304. |
| Tot | 81 | 81 | 78 | 71 | 59 | 24 | 62 | 62 | 32 | 72 | 76 | | | |
| Avg | 1.0 | 1.0 | 1.0 | 0.9 | 0.7 | 0.3 | 0.8 | 0.8 | 0.4 | 0.9 | 1.0 | 8.6 | | |

# Appendix 3.3: The publications used in mapping study for RQ1

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# Appendix 3.4: Main quality focus of publications under RQ2

| Publication | Main Quality Focus |
|---|---|
| (Govindasamy, 2001) | Explained the desirable attributes of e-Learning |
| (Wu and Wang, 2006) | Five variables (system quality, knowledge or information quality, perceived KMS benefits, user satisfaction, and system use) were used as dependent variables in evaluating KMS success, and their interrelationships were suggested and empirically tested. |
| (Fresen and Boyd, 2005) | The methodology of the quality management system, critical success factors for web-supported learning, and a student feedback survey measuring client satisfaction is described. |
| (Alkhattabi et al., 2011) | Proposed an assessment model for information quality in e-Learning systems based on the quality framework |
| (Ramayah et al., 2010) | The findings of the research concluded that system quality, information quality, and service quality are determinants of behavioural intention to use e-Learning. |
| (Black et al., 2007) | The attributes of to increase the likelihood adoption and implementation of LMS are identified as compatibility, relative advantage, trialability, complexity, and observability |
| (Christie and Jurado, 2009) | Offered a number of recommendations for ensuring that teachers embrace rather than resist a move to innovative and quality assured online education. |
| (Tikhomirova et al., 2008) | Explained the case study on model for successfully established Quality Management and E-Learning Systems |
| (Adeyinka and Mutula, 2010) | The study explained that content quality, system quality, support service quality, teaching and learning quality, self-regulated learning, intention to use, user satisfaction and net benefits are important factors for evaluating the success of WebCT CCMS. |
| (Meho and Kiduk, 2006) | Explained a multi-faceted approach to information quality assessment for KM |
| (Nevo et al., 2008) | Development and evaluation framework for Knowledge Management Systems (KMS) is explained. |
| (Rao and Osei-Bryson, 2007) | Dimensions that can be used to measure the quality of the knowledge management system and to compare KMS quality across systems are proposed. |
| (Kulkarni et al., 2007) | An integrated model that includes knowledge sharing and knowledge quality and their links to the desired outcome namely, knowledge reuse is developed |
| (Lauer, 2001) | Emphasised that producing useful organisational knowledge very much depends on having 'quality information' as a resource |
| (Ulrich et al., 2008) | The implementation of knowledge management with strict knowledge quality evaluation criteria aided by mobile manufacturing system will enhance the precision in process planning, optimization and decision making in automated manufacturing environment. |

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| (Ellis and Calvo, 2007) | Stated that “Quality assurance in higher education cannot simply focus on the what, such as the quality of graduates (however measured), or the quantity of employed graduates at a point in time. For one thing, there is no single measure of the quality of a graduate”. |
| (Alexander and Golja, 2007) | Explained that the nature of quality can be characterized as follows:” relates to values; entails criteria that are used and developed to make value judgments; and is derived and shaped over time by the subjective experiences of individuals or collective groups as they operate in changing environments with particular conditions and pressures”. |
| (Dan and Cristian, 2006) | A software development process that is specifically designed for implementing an on-line learning application |
| (Darbyshire, 2003) | It has mentioned the lack of definitive metrics for defining quality. “we can construct an environment which supports the development of quality on-line programs by using a combination of Total Quality Management and current best practice” |
| (Weaver et al., 2008) | Findings of the survey on quality assessment of LMS by considering varying levels of support provided to staff and students is explained |

# Appendix 3.5: Publications where each quality attribute is reported for RQ3

| | Quality attribute | Publications | Frequency |
|---|---|---|---|
| **Content quality** | | | |
| 1 | Content representation | (Alkhattabi et al., 2011) | 6 |
| | | (Wu and Wang, 2006) | |
| | | (Fresen and Boyd, 2005) | |
| | | (Kulkarni et al., 2007) | |
| | | (Lee and Lee, 2008) | |
| | | (Ozkan and Koseler, 2009) | |
| 2 | Consistency | (Alkhattabi et al., 2011) | 2 |
| | | (Wu and Wang, 2006) | |
| 3 | flexibility | (Ramayah et al., 2010) | 2 |
| | | (Ozkan and Koseler, 2009) | |
| 4 | Interactivity | (Fresen and Boyd, 2005) | 2 |
| | | (Ozkan and Koseler, 2009) | |
| 5 | Learning model | (Fresen and Boyd, 2005) | 2 |
| | | (Ozkan and Koseler, 2009) | |
| 6 | Clarity | (Fresen and Boyd, 2005) | 2 |
| | | (Ozkan and Koseler, 2009) | |
| 7 | Understandability | (Alkhattabi et al., 2011) | 4 |
| | | (Wu and Wang, 2006) | |
| | | (Kulkarni et al., 2007) | |
| | | (Georgouli et al., 2008) | |
| 8 | Tutorial structure | (Govindasamy, 2001) | 3 |
| | | (Fresen and Boyd, 2005) | |
| | | (Darbyshire, 2003) | |
| 9 | Up-to-datedness | (Wu and Wang, 2006) | 5 |
| | | (Ramayah et al., 2010) | |
| | | (Adeyinka and Mutula, 2010) | |
| | | (Fresen and Boyd, 2005) | |
| | | (Ozkan and Koseler, 2009) | |
| 10 | Learner assessment quality | (Govindasamy, 2001) | 3 |
| | | (Fresen and Boyd, 2005) | |
| | | (Ozkan and Koseler, 2009) | |
| 11 | Well-organised | (Fresen and Boyd, 2005) | 3 |
| | | (Kulkarni et al., 2007) | |
| | | (Ozkan and Koseler, 2009) | |
| 12 | Completeness | (Alkhattabi et al., 2011) | 5 |
| | | (Ramayah et al., 2010) | |
| | | (Adeyinka and Mutula, 2010) | |
| | | (Fresen and Boyd, 2005) | |
| | | (Darbyshire, 2003) | |
| 13 | Relevancy | (Alkhattabi et al., 2011) | 5 |
| | | (Ramayah et al., 2010) | |
| | | (Adeyinka and Mutula, 2010) | |

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|---|---|---|---|
| | | (Fresen and Boyd, 2005) | |
| | | (Darbyshire, 2003) | |
| 14 | Accuracy | (Alkhattabi et al., 2011) | 5 |
| | | (Ramayah et al., 2010) | |
| | | (Adeyinka and Mutula, 2010) | |
| | | (Fresen and Boyd, 2005) | |
| | | (Georgouli et al., 2008) | |
| 15 | Teaching and learning | (Alkhattabi et al., 2011) | 5 |
| | | (Govindasamy, 2001) | |
| | | (Ramayah et al., 2010) | |
| | | (Adeyinka and Mutula, 2010) | |
| | | (Fresen and Boyd, 2005) | |
| 16 | Reliability | (Govindasamy, 2001) | 5 |
| | | (Adeyinka and Mutula, 2010) | |
| | | (Fresen and Boyd, 2005) | |
| | | (Ozkan and Koseler, 2009) | |
| | | (Georgouli et al., 2008) | |
| 17 | Information contextual quality | (Wu and Wang, 2006) | 7 |
| | | (Govindasamy, 2001) | |
| | | (Adeyinka and Mutula, 2010) | |
| | | (Fresen and Boyd, 2005) | |
| | | (Lee and Lee, 2008) | |
| | | (Ozkan and Koseler, 2009) | |
| | | (Georgouli et al., 2008) | |
| 18 | Self-regulated learning | (Alkhattabi et al., 2011) | 4 |
| | | (Adeyinka and Mutula, 2010) | |
| | | (Fresen and Boyd, 2005) | |
| | | (Lee and Lee, 2008) | |
| 19 | Usefulness | (Wu and Wang, 2006) | 5 |
| | | (Adeyinka and Mutula, 2010) | |
| | | (Fresen and Boyd, 2005) | |
| | | (Kulkarni et al., 2007) | |
| | | (Lee and Lee, 2008) | |
| 20 | Academic performance | (Govindasamy, 2001) | 3 |
| | | (Lee and Lee, 2008) | |
| | | (Georgouli et al., 2008) | |
| **Platform quality** | | | |
| 21 | Easy to use | (Wu and Wang, 2006) | 7 |
| | | (Ramayah et al., 2010) | |
| | | (Adeyinka and Mutula, 2010) | |
| | | (Fresen and Boyd, 2005) | |
| | | (Kulkarni et al., 2007) | |
| | | (Lee and Lee, 2008) | |
| | | (Ozkan and Koseler, 2009) | |

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|---|---|---|---|
| 22 | Security | (Ramayah et al., 2010) | 3 |
| | | (Adeyinka and Mutula, 2010) | |
| | | (Ozkan and Koseler, 2009) | |
| 23 | Reliability | (Ramayah et al., 2010) | 4 |
| | | (Adeyinka and Mutula, 2010) | |
| | | (Fresen and Boyd, 2005) | |
| | | (Ozkan and Koseler, 2009) | |
| 24 | Usability | (Ramayah et al., 2010) | 2 |
| | | (Ozkan and Koseler, 2009) | |
| 25 | Help option available | (Ramayah et al., 2010) | 2 |
| | | (Ozkan and Koseler, 2009) | |
| 26 | User friendly | (Wu and Wang, 2006) | 2 |
| | | (Ozkan and Koseler, 2009) | |
| 27 | Well-organised | (Fresen and Boyd, 2005) | 2 |
| | | (Ozkan and Koseler, 2009) | |
| 28 | Availability | (Alkhattabi et al., 2011) | 5 |
| | | (Ramayah et al., 2010) | |
| | | (Adeyinka and Mutula, 2010) | |
| | | (Fresen and Boyd, 2005) | |
| | | (Ozkan and Koseler, 2009) | |
| 29 | Personalization | (Ramayah et al., 2010) | 2 |
| | | (Ozkan and Koseler, 2009) | |
| 30 | Interactivity | (Ozkan and Koseler, 2009) | 1 |
| 31 | Accessibility | (Alkhattabi et al., 2011) | 4 |
| | | (Ramayah et al., 2010) | |
| | | (Fresen and Boyd, 2005) | |
| | | (Kulkarni et al., 2007) | |
| 32 | Response Time | (Alkhattabi et al., 2011) | 5 |
| | | (Wu and Wang, 2006) | |
| | | (Ramayah et al., 2010) | |
| | | (Adeyinka and Mutula, 2010) | |
| | | (Fresen and Boyd, 2005) | |
| 33 | Easy to communicate | (Adeyinka and Mutula, 2010) | 3 |
| | | (Fresen and Boyd, 2005) | |
| | | (Ozkan and Koseler, 2009) | |
| **User satisfaction** | | | |
| 34 | Efficiency and effectiveness | (Wu and Wang, 2006) | 5 |
| | | (Adeyinka and Mutula, 2010) | |
| | | (Fresen and Boyd, 2005) | |
| | | (Ellis and Calvo, 2007) | |
| | | (Teo, 2010) | |
| 35 | Intention to use | (Ramayah et al., 2010) | 4 |
| | | (Adeyinka and Mutula, 2010) | |
| | | (Lee and Lee, 2008) | |

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|---|---|---|---|
| | | (Teo, 2010) | |
| 36 | Learner attitudes toward KMSS | (Fresen and Boyd, 2005)<br>(Ozkan and Koseler, 2009) | 2 |
| 37 | Enjoyable experience | (Adeyinka and Mutula, 2010)<br>(Ozkan and Koseler, 2009) | 2 |
| 38 | Learners’ study habits | (Fresen and Boyd, 2005)<br>(Lee and Lee, 2008)<br>(Ozkan and Koseler, 2009) | 3 |
| 39 | Motivation/commitment/self esteem | (Adeyinka and Mutula, 2010)<br>(Fresen and Boyd, 2005)<br>(Lee and Lee, 2008) | 3 |
| 40 | Communication with fellow learners | (Adeyinka and Mutula, 2010)<br>(Fresen and Boyd, 2005)<br>(Ozkan and Koseler, 2009)<br>(Teo, 2010) | 4 |
| 41 | Time management/time on task | (Adeyinka and Mutula, 2010)<br>(Fresen and Boyd, 2005)<br>(Teo, 2010) | 3 |

# Appendix 3.6: Methods of assessing quality reported in each publication for RQ4

| Publication | Methods of assessing quality |
|---|---|
| (Fresen and Boyd, 2005) | Student satisfaction survey: The WebCT (2002) student feedback questionnaire in this case study is based on the following categories: personal information (four items); technical adequacy and technical support (11 items); educational support (supportive resources and training) (two items); affective domain (feelings and emotions of students) (four items); interactivity (use of communication tools) (two items); perceived learning (four items). Items within each category were measured on a 5-point Lickert scale ranging from 'Strongly Disagree', to 'Strongly Agree', with a central neutral option. In order to calculate metrics to measure client satisfaction with web-supported learning, satisfaction and frustration indices were computed. |
| (Ellis and Calvo, 2007) | Questionnaire survey: This study describes a set of institutional indicators that suggest minimum standards for the quality assurance of learning supported by learning management systems in blended contexts. The indicators are evaluated by comparing seven universities that use a common learning management system to support student learning experiences. The responses to a qualitative questionnaire provide evidence of how the participating universities approach leadership, policy making, development, and evaluation as they relate to the quality assurance of learning management systems. A comparison among the universities reveals that they tend to have a better understanding of technical rather than educational issues related to quality assurance. |
| (Alexander and Golja, 2007) | Benchmarking: Give an account of two major evaluation studies at the University of Technology, Sydney (UTS), utilising a systems approach to investigate the consequences of e-Learning, and inquire into the value of this particular institutional approach for deriving e-Learning quality. It has used selections from the large dataset to describe and analyse students' and teaching staff's experiences of an e-Learning system (LMS) over a two-year period. |
| (Darbyshire, 2003) | Student satisfaction survey: This paper discusses student satisfaction and program quality using an example of an on-line MSc. program as a case study. It has emphasised that if the on-line programs are designed around 'best practice', and delivered by qualified instructors through accredited institutions then satisfaction surveys could be indicative of 'quality'. |
| (Weaver et al., 2008) | Institutional survey: This paper presents findings from an institutional survey investigating the use of *WebCT* by academic staff and students in their learning and teaching at a large |

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| | Australian university. The findings in this paper have implications for quality teaching and learning with technology, and the way in which tertiary institutions support academic staff. |
| (Lee and Lee, 2008) | By measuring self-regulatory efficacy: The learner's independent assessment of self-regulatory learning ability is called self regulatory efficacy (SRE; Bong, 1998). According to the cognitive psychology theory, SRE is the efficacy of well performed self-regulatory mechanisms such as self observation, self-judgment and self-response. This study suggests a research model which is based on an e Learning success model as well as the relationship of the e-Learner's self-regulatory efficacy, and the quality perception of the e-Learning environment. The presented research model focuses on the learning environment and on the learners' self-efficacy. |
| (Ozkan and Koseler, 2009) | Student survey (Undergraduate and post graduate students): This study proposes a conceptual e-Learning assessment model, hexagonal e-Learning assessment model (HELAM) suggesting a multi-dimensional approach for LMS evaluation via six dimensions: (1) system quality, (2) service quality, (3) content quality, (4) learner perspective, (5) instructor attitudes, and (6) supportive issues. A survey instrument based on HELAM has been developed and applied to 84 learners. This sample consists of students at both undergraduate and graduate levels who are users of a web-based learning management system, U-Link, at Brunel University, UK. |
| (Wu and Wang, 2006) | Empirically tested using hypothesis testing: This paper has proposed and empirically assessed a KMS success model. This was derived through an analysis of current practice of knowledge management and review of IS success literature. Five variables (system quality, knowledge or information quality, perceived KMS benefits, user satisfaction, and system use) were used as dependent variables in evaluating KMS success, and their interrelationships were suggested and empirically tested. |
| (Georgouli et al., 2008) | Questionnaire survey on quality of learning materials provided on LMS: Based on this experience and on the results from the evaluations they have conducted in the last few years (3 surveys with 316 participants), they claimed that e-Learning methods and tools can indeed help in efficiently supporting the students and in improving the quality of learning. |
| (Nagel and Kotzé, 2010) | Survey on Community of Inquiry (CoI) to measure three presences in e-Learning: social, teaching and cognitive. These presences overlap and are related to each other. They all contribute towards the formation of a learning community. CoI-framework is a valid and dependable instrument to measure the |

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| | quality of online teaching. |
| (Cavus, 2010) | Using a computer program in the form of an algorithm: For the quick and efficient evaluation of the LMS systems using smart algorithm derived from artificial intelligent concepts with fuzzy logic values. The program is named as Easy Way to Evaluate LMSs (EW-LMS) and it is fundamentally a web-based decision support system (DSS) that may help the users to choose the best LMS system depending on their needs and their type of usage. |
| (Moussa and Moussa, 2009) | Adopting international measures of quality assurance (recommendations for developing countries). |
| (Pond, 2001) | Using quality assurance measures by considering universal attributes of quality education : continuity between ''advertising'' and reality, continuity between purpose and practice, preparation for external credentialing/further study, personal/professional/academic growth for the learner, relevance, rich, multidirectional interaction, functional, ''user-friendly'' interface, adequate resources for: instructors, learners, curriculum, appropriate assessment methods/opportunities. |
| (Teo, 2010) | Survey on E-Learning acceptance: A total sample of 386 university students from a teacher training institute in an Asian country participated in this study. Comprising two studies, the first study (n=197) initiated a generic questionnaire, and examined factorial validity and reliability. The second study (n=189) used confirmatory factor analysis to establish factorial validity and measurement invariance by gender using a different sample. A correlated three-factor model (tutor quality, perceived usefulness, and facilitating conditions) was fit using maximum likelihood estimation (MLE). |
| (Buyukozkan et al., 2010) | An axiomatic design based approach for fuzzy group decision making is adopted to evaluate the quality of e-Learning web sites: Axiomatic Design (AD) principles provide a powerful tool to measure how well system capabilities respond to functional requirements. The ultimate goal of AD is to establish a scientific basis for design and to improve design activities. Another multi-criteria decision making technique, namely fuzzy TOPSIS, is applied in order to validate the outcome. |
| (Connolly et al., 2005) | Through a model of quality assurance: Approaches to quality assurance, transformation and enhancement used at the university through a model of quality assurance specifically designed to ensure that the quality of the new forms of delivery was as robust and rigorous as that of the more traditional face-to-face delivery methods. |
| (Concannon et al., 2005) | Hypothesis testing on quality: Based on expectancy disconfirmation theory (EDT) model for e-Learning |

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| | continuance in the e-Learning context by decomposing the perceived performance construct into usability, quality and value and adding disconfirmation constructs of them to the model and examining their effects on user satisfaction and continuance intention. Overall, the results provided strong support for the hypotheses and help clarify the roles of usability, quality, and value in the satisfaction formation process. |
| (Fardoun et al., 2009) | Using ISO 9126-1 software quality model: This model identifies six main quality characteristics, namely: functionality, reliability, usability, efficiency, maintainability and portability. |
| (Pah et al., 2008) | Quality management of all university's aspects, including e-Learning, through an advanced web-based, multi agent, knowledge management system. The proposed solutions have advanced functions for extracting the quality indicators from the university data base, online analysis of indicators' values and for recommending the suitable measures in order to adjust inappropriate values of individual indicators. |

# Appendix 3.7: Methods of evaluating learning effectiveness reported in each publication for RQ5

| Publication | Method used for evaluating learning Effectiveness |
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| (Lee and Lee, 2008) | E-Learning effectiveness is evaluated based on models of educational engineering variables and information systems which will be verified theoretically or empirically. Variable considered for evaluating learning effectiveness is known as self-regulatory efficacy. |
| (Ozkan and Koseler, 2009) | Proposes a conceptual e-Learning assessment model called hexagonal e-Learning assessment model (HELAM) suggesting a multi-dimensional approach for LMS evaluation via six dimensions: (1) system quality, (2) service quality, (3) content quality, (4) learner perspective, (5)instructor attitudes, and (6) supportive issues. Effectiveness of e-Learning is measured using a survey on satisfaction of undergraduate and post graduate students |
| (Georgouli et al., 2008) | Questionnaire survey on quality of learning materials provided on LMS. Case study on successful transition to blended learning which include survey on level of support to students and improving the quality of learning |
| (Tsianos et al., 2010) | An extensive empirical study that was conducted in order to evaluate the role of Working Memory (WM) span in educational hypermedia and, mainly, to assess the effectiveness of corresponding personalization techniques in terms of actually assisting learners with low levels of WM span in improving their performance. Measuring learners' working memory (WM) capacity, on examining the differences in performance in relation to WM resources, and finally on improving the performance of learners with lower levels of WM span. |
| (Brew, 2008) | Questionnaire survey to investigate three related questions: (1) Will students provide detailed feedback if given the opportunity to complete an anonymous survey? (2) Will embedding an online survey within the course management software be an effective method of gathering feedback? (3) Will student feedback contain constructive critical information that will prove useful in evaluating and revising the course? |
| (Cavus, 2010) | Learning effectiveness is assessed as one of the factors in evaluating LMS. The developed system is basically a web-based decision support system used to evaluate LMSs by using a flexible and smart algorithm derived from artificial intelligent concepts with fuzzy logic values. |
| (Chang and Chen, 2009) | Based on the concept of student-centered learning, a fuzzy peer assessment system (FPAS) is developed to satisfy the requirements of cooperative learning in an E-Learning |

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| | environment. |
| (Derntl and Motschnig-Pitrik, 2005) | Empirical evaluation of the contribution of visual modelling of blended learning scenarios, on their semi-formal description as patterns, and on the use of patterns as sources for user centered web support modules. |
| (Fernández-Breis et al., 2009) | Performance evaluation in individual and group work. The framework presented in this paper ranks and mark students according to the knowledge they acquire during the group work. For this purpose, the knowledge generated by the group is audited and classified into common, private and inconsistent knowledge. Common knowledge is acquired by most group members. Private knowledge is only acquired by one student. Students having private knowledge can be considered the group experts in such area. Finally, inconsistent knowledge represents learning flaws in the group, since the different members are learning incompatible knowledge. |
| (Martínez et al., 2007) | Qualitative analysis of the content of the three hundred and fifty six (356) messages written by the participants in the virtual environment was undertaken. The aspects analysed were: adaptation to virtual environment, content, resources, timing, tasks, students' characteristics, students' interaction and students-facilitator interaction. |
| (Paechter et al., 2010) | Qualitative online interviews for evaluating aspects of e-Learning students consider important for their learning achievements and course satisfaction. This question was addressed by surveying 2196 students from 29 universities in Austria about their expectations of, and experiences in e-Learning. Multiple regression analyses using Mplus 4.21 were carried out to investigate how different facets of students' expectations and experiences are related to perceived learning achievements and course satisfaction. |
| (Reid, 2001) | The evaluation of teaching by students via online methods. The system can be accessed in flexible ways and can incorporate feedback from students learning in a range of contexts and locations, feedback can be summarised and responded to efficiently, quantitative and qualitative information can be readily analysed. In addition, for the increasing number of students who are engaging in online learning experiences, it provides an evaluation mechanism that is congruent with their learning environment. |
| (Teo, 2010) | Tutor quality, perceived usefulness, and facilitating conditions measures users' acceptance of e-Learning. E-Learning Acceptance Measure (ElAM) comprising two studies, the first study (n=197) initiated a generic questionnaire, and examined factorial validity and reliability. The second study (n=189) |

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| | used confirmatory factor analysis to establish factorial validity and measurement invariance by gender using a different sample. A correlated three-factor model (Tutor quality, perceived usefulness, and facilitating conditions) was fit using maximum likelihood estimation (MLE) and found to be adequate. |
| (Wang, 2008) | Multiple-choice Web-based quiz-game-like formative assessment system, named GAM-WATA. This research also compares the effectiveness of three different types of formative assessment in an e-Learning environment: paper-and-pencil test (PPT), normal Web-based test (NWBT) and GAM-WATA. |
| (Tseng and Tsai, 2010) | Measuring students' online peer assessment self-efficacy (OPASS)- self-efficacy scales: evaluating, receiving and reacting and their motivations in online peer assessment learning environments (MOPAS)- two scales: intrinsic motivation and extrinsic motivation were developed. |
| (Andersson and Hatakka, 2010) | Case study to explore if, and how, the use of technology can increase the level of interactivity in distance educations and thereby enable a change in learning culture .We therefore analyse the cases to see if, and how, an increase in interactivity can support this paradigm shift. |
| (Chao and Chen, 2009) | Evaluate the factors (or criteria) in a distance e-Learning system which includes synchronous and asynchronous learning. This method is named consistent fuzzy preference relations (CFPR). Using CFPR in AHP structures can easily establish the multi-criteria decision-making matrices and successfully rate the weight of each criterion of the distance web e-Learning systems. According to these weights, the e-Learning performance can be directly evaluated with the scores given by the evaluator to the main criteria and computed by using the expected value. |
| (Gierlowski and Nowicki, 2009) | Using web-based technologies with loosely-tied distributed system architecture, strict modularity, test and simulation-based knowledge and skill assessment package called Communication Abstraction Layer (ComAL) |
| (Hong-Ren and Hui-Ling, 2010) | Evaluating the system acceptance by questionnaire survey on behavioural intention of the system acceptance by evaluating perceived easy to use and perceived usefulness. Perceived usefulness is the key factor for learners’ willingness to be guided through the system’s learning process. |
| (Jennex, 2008) | A case for using “intent to use” as a measure of KM/KMS success rather than quantity of “use.” To make this case, data gathered from a review of published research plus data gathered from a longitudinal study of KM/KMS in an |

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| | engineering organisation is presented that illustrates that quantity of "use" measures fail to predict success and that "intent to use" measures may predict success. |
| (Kale and Richardson, 2006) | Evaluation of effective use of e-Learning is carried out by questionnaire, informal feedback from students and electronically recorded activity statistics. |
| (Kılıç-Çakmak et al., 2009) | Examining the expectations of first year students enrolled in an e-Learning program with respect to factors influence the effectiveness of e-Learning: teaching-learning, instructor, assessment and evaluation, communication, and technical support. |
| (Kim and Lee, 2008) | Survey on validating a model for evaluating learning management systems (LMS) used in e-Learning fields using Factor Analysis Factor I was labelled as 'instruction management, screen design, and technology' and factor II, 'interaction and evaluation'. |
| (Lee and Kang, 2005) | Study on perceived usefulness reported by the participants of Intranet Based Learning (IBL) and the effectiveness of IBL measured by the outcomes of two instructional groups and the control group in a Korean private company analysed using the two-factor ANOVA . |
| (Mohayidin et al., 2007) | Analysing the level of practice among the academicians and determining factors contributing to the effectiveness of knowledge management practices at individual, faculty and university level. The factors in shaping the KM initiatives are identified as info-structure support; infrastructure capacity; info-culture; and knowledge acquisition, generation, storage and dissemination. |
| (Poston and Speier, 2005) | Examining how content ratings and credibility indicators affect KMS users' search and evaluation processes and decision performance (how well and how quickly users selected alternatives offered by the KMS). Four interrelated laboratory experiments provide evidence that ratings have a strong influence on KMS search and evaluation processes, which in turn affects decision performance. |
| (Shee and Wang, 2008) | A multi-criteria methodology from the perspective of learner satisfaction to support those evaluation-based activities taking place at the pre- and post-adoption phases of the web-based e-Learning system (WELS) life cycle. This investigation carried out a survey of college students, and the data thus obtained was then analysed by analytic hierarchy process in order to derive an integrated preference structure of learners as a ground for evaluation. |

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| (Tseng, 2008) | A management-oriented conceptual framework to describe the influence KMS performance in implementing the KMS. By partitioned the activities of KMS into three processes: KM strategic, the plan of KM, and implementation of KM plan, the study explores the KMS performance indicators which are useful to assess the KMS performance for firms. |
| (Wills et al., 2009) | A Community-based Reference Model for the development of services within a large service-oriented framework for assessment in e-Learning. e-Framework Reference Model for Assessment (FREMA) project that aimed at creating a reference model for the assessment domain: a guide to what resources (standards, projects, people, organisations, software, services and use cases) exist for the domain, aimed at helping strategists understand the state of e-Learning assessment, and helping developers to place their work in context and thus the community to build coherent systems. |
| (Zhao, 2010) | Using performance assessment mechanism of knowledge applications and development as a method to facilitate teacher learning and improve teacher professional development. |
| (Bouarab-Dahmani et al., 2010) | An evaluation process that is based on a gradual approach, which starts with an analysis of the form of the solution proposed by the learner. A semantic analysis detects semantic errors that render the learner's solution inadequate to the exercise statement. |
| (Chiu et al., 2005) | A case study is conducted in order to evaluate several e-Learning web sites according to these functional requirements with group fuzzyAD. Fuzzy AD methodology is based on the conventional AD; however, crisp ranges are replaced by fuzzy numbers that represent linguistic terms. For measuring intangible criteria such as reliability, responsiveness, etc., fuzzy AD is applied to translate linguistic terms into performance measures. Also, group consensus is sought throughout the study and therefore, fuzzy AD model is enhanced with a group decision making tool. |
| (Ginns and Ellis, 2009) | Use of psychometric functioning of a proposed e-Learning scale in relation to a well-validated degree-level teaching evaluation instrument, named Student Course Experience Questionnaire. Using confirmatory factor analysis, examined whether the proposed items of e-Learning scale formed a scale which was distinct from other core scales of a degree-level teaching evaluation instrument already in use within the university. |
| (Grubisic et al., 2009) | The methodology for conducting controlled experiment replication, as well as, results of a controlled experiment and an internal replication that investigated the effectiveness of |

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| | intelligent authoring shell eXtended Tutor–Expert System (xTEx-Sys). The initial and the replicated experiment were based on our approach that combines classical two-group experimental design and with factoral design. A trait that distinguishes this approach from others is the existence of arbitrary number of checkpoint-tests to determine the effectiveness in intermediate states. It is called a pre-and-post test control group experimental design with checkpoint-tests. |
| (Ho and Dzeng, 2010) | Effectiveness of e-Learning for delivering construction safety education training and how to assess its effectiveness by employing interview, test, questionnaire, observation, and document analysis. A two-stage materials analysis was performed in this study. At the first stage, different learning and training results generated from different education training mode of Project A, Project B, Project C were investigated. According to the analysis results of the first stage, a questionnaire survey was performed the second stage. The labor safety education training of e-Learning mode was tested for e-Learning effectiveness through questionnaire for two construction projects with similar attributes. |
| (Jara and Mellar, 2010) | Content rating schemes (i.e., users of the KMS submit ratings to indicate the quality of specific content used) and credibility indicators (indicators describing the validity of the content and/or the ratings) to improve users' search and evaluation of KMS content. This study examines how content ratings and credibility indicators affect KMS users' search and evaluation processes and decision performance (how well and how quickly users selected alternatives offered by the KMS). Four interrelated laboratory experiments provide evidence that ratings have a strong influence on KMS search and evaluation processes, which in turn affects decision performance. |
| (Kalyuga and Sweller, 2005) | Evaluating learner expertise based on assessment of the content of working memory and the extent to which cognitive load has been reduced by knowledge retrieved from long-term memory. The method was tested in an experiment with an elementary algebra tutor. |
| (Oladiran and Uziak, 2009) | A study on students' perception of the e-Learning technology, namely WebCT/Blackboard. The study surveyed a cohort of third year mechanical engineering students to obtain their perceptions about the use of Blackboard platform. An online questionnaire was used as an instrument for gathering data from the students. The questionnaire consisted of three sections made up of 92 items that covered such areas as technology acceptance, resources, access, instruction, and quality issues. An open ended question enabled students to comment on access to eLearning resources. |

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| (Wang, 2007) | The web-based formative assessment developed in this research is named Formative Assessment Module of the Web-based Assessment and Test Analysis System (FAM-WATA). FAMWATA is a multiple-choice web-based formative assessment module containing six effective strategies: 'repeat the test', 'correct answers are not given', 'query scores', 'ask questions', 'monitor answering history', and 'all pass and then reward'. This research not only applied FAM-WATA to assist teachers in giving feedback and interacting with students in an e-Learning environment but also explored the effectiveness of FAM-WATA in facilitating student e-Learning effectiveness. |
| (Yang et al., 2007) | Applying social networks to enhance the quality of e-Learning regarding knowledge sharing in virtual learning community by overcoming two barriers: difficulty in finding quality knowledge and difficulty in finding trustworthy learning collaborators. The results of this research demonstrate that applying such mechanisms to knowledge sharing do improve the quality of e-Learning in virtual learning communities. |
| (Zhang et al., 2006) | Empirical study examined the influence of interactive video on learning outcome and learner satisfaction in e-Learning environments. Four different settings were studied: three were e-Learning environments with interactive video, with non-interactive video, and without video. The fourth was the traditional classroom environment. Results of the experiment showed that the value of video for learning effectiveness was contingent upon the provision of interactivity. Students in the e-Learning environment that provided interactive video achieved significantly better learning performance and a higher level of learner satisfaction than those in other settings. However, students who used the e-Learning environment that provided non-interactive video did not improve either. |
| (Zhang et al., 2010) | A method of assessment on how Human-Computer Interaction (HCI) and animation influence the psychological process of learning by comparing a traditional web design course and an e-Learning web design course, based on the Change of Internal Mental Model of Learners. This paper applies the cognitive learning theory into designing the E-Learning course, in order to analyse the psychological process of learning when a learner learns a course; and tests how the psychological process of learning will be affected by different learning methods. |
| (Konstantinidis et al., 2009) | This paper presents the results of three small scale studies carried out in a tertiary education department, to assess the educational environment. This environment has been evaluated based on a hybrid evaluation methodology for uncovering usability problems, collecting further requirements for additional functionality to support collaborative virtual |

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| | learning environments, and determining the appropriateness of different kinds of learning scenarios. This evaluation process includes three phases: (a) Pre-analysis phase, which includes the Pre-test session; (b) Usability phase, which includes two sessions: (i) Familiarisation session (usability session 1) and (ii) Co-presence session (usability session 2) and (c) Learning phase, which includes a learning scenario-based session. |
| (Tsianos et al., 2010) | An extensive empirical study that was conducted in order to evaluate the role of WM span in educational hypermedia and, mainly, to assess the effectiveness of corresponding personalisation techniques in terms of actually assisting learners with low levels of WM span in improving their performance. According to Baddeley, "the term working memory refers to a brain system that provides temporary storage and manipulation of the information necessary for such complex cognitive tasks as language comprehension, learning, and reasoning" |
| (Ounaies et al., 2008) | Using a measurement framework to assess adaptively performance focusing on adaptation methods alignment with usage and business factors. Adaptation systems aim to provide personalised services to the users. Systems that allow the user to change certain system parameters and adapt their behaviour accordingly are called adaptable. |

# Appendix 5.1: Features of KMS platforms

## Microsoft Office 365

Among the more robust and cost effective online tools, Microsoft Office 365 products continue to be a mainstay for professionals and business organisations. Functions included in Microsoft Office 365 are familiar online tools everyone is using today, like discussion boards, blogs, and wikis that are necessary for team productivity and collaboration. Video meetings, teleconferencing, and chat help to accommodate different user preferences for getting in touch as needs arise. Homepage of the Office 365 is shown in Figure 1.

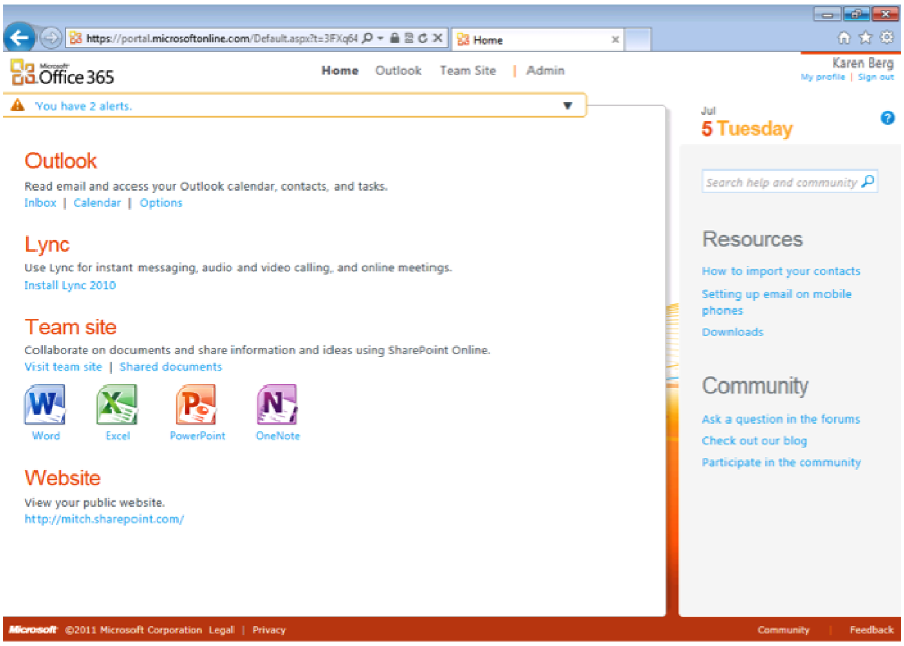



Figure 1 Homepage of Office 365(source:http://community.office365.com)

With Office 365, you can take advantage of sophisticated collaboration and messaging capabilities without the operational burden of on-premises server software. Microsoft Office 365 keeps you in control and provides business-class reliability, high availability; comprehensive security, simplified management, and familiar user interface so that you can confidently choose it as the collaboration and communication solution for your institution.

Although selection of suitable knowledge management software depends on requirements of the organisation, Office 365 as a cloud based software has many advantages over other commercial software as explained above. Feature and tool available in Microsoft Office 365 services offering gives the powerful productivity capabilities of SharePoint Online, Exchange Online, and Lync Online, as well as Office Professional Plus and Office Web Apps(web-based versions of Excel, Word and PowerPoint) making it easier for both students and educators to quickly and cost effectively access up-to-date collaboration, communication, and productivity services. Following section gives the details of features and tools of Office 365 which supports enterprise Knowledge Management.

## SharePoint Online

Microsoft SharePoint Online brings together the familiar Microsoft SharePoint Server technology now delivered as an online service. SharePoint Online helps businesses create sites to share documents and insights with colleagues, partners, and customers.

*Features:*

- Manage and share personal documents and insights with colleagues by using MySites.

- Keep teams in sync with shared document libraries, task lists, and calendars with Team Sites.
- Stay up to date on company news, events, and business updates with Intranet Sites.
- Create Microsoft Office documents and save them directly to SharePoint Online.
- A single console for service provisioning, monitoring, and reporting to simplify management.
- Protect sensitive content with document-level permissions.
- Access important documents offline by using SharePoint Workspace.
- Enable real-time communication with colleagues from within SharePoint Online.

**Exchange Online**
Exchange Online provides rich, familiar, and more secure access to email, calendar, contacts, and tasks across PCs, the web, and mobile devices. It delivers the robust capabilities of Microsoft Exchange Server as a cloud-based service. In addition to delivering powerful and familiar Exchange Server capabilities, Exchange Online greatly simplifies IT management and provides advanced security and reliability features that help to safeguard data.

*Features:*
Exchange Online provides the core features of Exchange Server, including:

- Large mailboxes: Each user gets 25 GB of mailbox storage standard and the ability to send attachments up to 35 MB in size.
- Antivirus/anti-spam: Forefront Online Protection for Exchange is included, providing multiple filters and virus-scanning engines to help protect your organization from spam, viruses, and phishing scams.
- Web-based access: For web-client access, Outlook Web App provides a premium browser-based experience that matches the look and feel of the full Outlook client.
- Mobility: Mobile access is available from all phones capable of receiving email, including Windows Phone, iPhone, Android, Palm, and Nokia and Blackberry devices.
- Shared calendar and contacts: Users can compare calendars to schedule meetings with Exchange Online and have access to collaboration features like shared calendars, groups, global address list, external contacts, tasks, conference rooms, and delegation.

**Lync Online**
Lync Online provides next-generation communications capabilities, including presence, IM, and PC-to-PC audio and video calling. Lync Online provides enterprise-class communications features that can improve the productivity of your people, drive their business efficiencies, and build a more agile organisation by providing a powerful combination of presence awareness and IM.

*Features:*

- Connect with others through instant messaging (IM), video calls, Lync contact photos, activity update feed, and interactive contact card in Microsoft Office.
- Conduct online presentations to customers and colleagues including audio, video, screen sharing, and a virtual whiteboard.
- Invite external contacts to easily join online meetings through a native or web-based client.
- Communicate with external organisations running Lync by using IM, audio, and video through Lync federation.

- Connect with Windows Live Messenger contacts by using IM, audio, and video calls directly from Lync.
- View presence status and click to communicate from within Microsoft Outlook, SharePoint, and other Office applications.

**Office Professional Plus**
With Office Professional Plus, your people are equipped with powerful ways to do their best work from more places—whether they're using a PC, phone, or web browser. As part of Office 365, Office Professional Plus delivers the complete, familiar, and intuitive applications you need to keep your business connected.

*Features:*
- Manage the inbox and calendar with Conversation View and other advanced management tools in Microsoft Outlook.
- Leverage the power of business and social networking within Outlook with the Outlook Social Connector.
- Collaborate with control and confidence with real-time co-authoring.
- Instantly share slideshows across town or around the world with Microsoft PowerPoint Broadcast Slide Show.
- Create enhanced presentations using new video and photo editing tools in PowerPoint.
- Work from virtually any place and on any device with Office Web Apps.

**Google Apps**
Google Apps is a cloud-based productivity suite that helps you and your team connect and get work done from anywhere on any device. It's simple to setup, use and manage, allowing you to work smarter and focus on what really matters.

Google Apps is a service from Google providing independently customisable versions of several Google products under a custom domain name. It features several Web applications with similar functionality to traditional office suites, including Gmail, Google Groups, Google Calendar, Talk, Docs and Sites. Google Apps helps to reduce both company's overall expenses and its environmental impact which supports the use of green technology. Apps is powered by Google's energy-efficient data centers, so it's less energy and carbon-intensive than on-premise servers.

**Lotus Notes**
Lotus Notes is a database system. Used for the foundation of the asynchronous system built by the SUNY Learning Network, it provides faculty with the option of a pre-designed template or creating template. The software is very similar to programs most faculty are familiar with on their computers. The software accommodates text, graphics, audio and video mediums. It allows for individual as well as small and large group assignments. Typical assessment methods used in determining learning outcomes include participation in discussions; papers; presentations; tests made up of short answer, multiple choice, True/False or combinations of all three; and self-tests. Lotus Notes has the value added components of multi-media elements, threaded discussions, hotlinks within the course and out to the Internet, the value of archiving an entire course including all faculty and student documents and communications, and access to one's

course 24/7 through the web. An advantage of Lotus Notes for the instructor is that all work can be done offline and then uploaded to the web while downloading students' latest submissions.

*Features of Lotus Notes are:*

- Quickly access workflow-driven and collaborative business applications that support a wide variety of business functions.
- Stay focused on your work by quickly pivoting to a wide variety of social tools that help you connect with people including email, calendars, presence awareness, instant messaging, profiles, status updates, file sharing, and more.
- Helps users manage their ever-growing inboxes effectively, with full-text search, delegation, mail filtering and sorting, conversation views and flags.
- Helps increase user productivity with customisable widgets that can recognise specific patterns of text in Lotus Notes documents; recognised text can be clicked to perform the appropriate business action associated with that widget, such as retrieving information from a flight number in an e-mail.
- Helps minimise or eliminate the impact of computer viruses through robust security features.
- Work when and where you need to, rather than only when you have a network connection with advanced replication technology that automatically synchronizes changes when you reconnect.

**WebCT (merged with BlackBoard)**

WebCT is used in more than 2,500 institutions in 81 countries around the world and is available in 10 major world languages (WebCT, 2002). WebCT's strategy is to deliver the best-of-breed learning tools, robust content management capabilities, dynamic learning information management, enhanced learning personalisation, enterprise-class architecture and strategic implementation services that institutions will need to compete effectively, today and years from now. (WebCT, 2002). WebCT is an icon driven software tool. Faculty link html documents, PowerPoint presentations or URLs to icons so that students click to read the material. They can also link several html documents together and WebCT builds a table of contents for the documents. Faculty can create organiser pages for modules or even resources. They have the option of customising the layout by modifying headers, footers, navigation menus, and colour schemes throughout their courses. Faculty can customise banners, backgrounds, and images by uploading them into the course making a course or set of courses completely unique.
Typical assessment methods used in determining learning outcomes include tests made up of short answer, multiple choice, True/False or combinations of all three; surveys and self-tests. WebCT accommodates text, graphics and audio and video mediums by storing them in a file manager in which faculty can organise and retrieve documents.

**Blackboard**
Blackboard is particularly used as a courseware that brings added value to traditional education. It was founded in June 1997 and has grown to serve many of the largest, innovative, and best-known institutions. Blackboard is the dominant commercial LMS, that provide a single platform to manage online teaching and learning(Dave Bremer and Bryant,

2005). Blackboard builds on the belief that effective use of course management tools plays an integral part in developing quality online education (Yaskin, D. & Gilfus, S. 2001).
A Blackboard course consists of a navigation path, a button bar and content frames. Faculty type or upload their course materials into Blackboard. Blackboard can accommodate text, graphics and audio mediums.
The course material does not have to be html documents. Faculty can load Word documents or even PowerPoint presentations. The navigation path allows users to return to any page accessed between the main course page and the current pages. The button bar links users to the available content areas and tools. The content frame displays web pages accessed through the button or navigation path. Typical assessment methods used in determining learning outcomes include tests made up of short answer, multiple choice, True/False or combinations of all three.

**Moodle**
Moodle (abbreviation for Modular Object-Oriented Dynamic Learning Environment) is a free source e-Learning software platform, also known as a Course Management System, Learning Management System, or Virtual Learning Environment (VLE). As of October 2012 it had a user base of 70,793 registered and verified sites, serving 63,204,814 users in 6.7+ million courses with 1.2+ million teachers(Lee et al., 2011).
Moodle is a web-based Learning Content Management System (LCMS), i.e. a way of knowledge management which is also called Course Management System (CMS) and VLE designed around pedagogical principles, namely a social constructivist philosophy using the collaborative possibilities of the Internet (Zenha-Rela and Carvalho, 2006). Moodle has many features expected from knowledge management software, particularly from an e-Learning platform including Forums, content management (Resources), Quizzes with different kinds of questions and several activity modules.

Moodle was originally developed by Martin Dougiamas to help educators create online courses with a focus on interaction and collaborative construction of content, and is in continual evolution. The first version of Moodle was released on 20 August 2002.

The Moodle project comprises several distinct but related elements, namely

- The software
- Moodle Pty Ltd (also known as Moodle Headquarters or the Moodle Trust, based in Perth, Western Australia), an Australian company which performs the majority of the development of the core Moodle platform.
- The Moodle Community, an open network of over one million registered users who interact through the Moodle community website to share ideas, code, information and free support. This community also includes a large number of non-core developers, with Moodle's free source license and modular design allowing any developer to create additional modules and features that has allowed Moodle to become a truly global, collaborative project in scope.
- The Moodle Partner network, which forms the commercial arm of the Moodle environment and provides the bulk of the funding to Moodle Pty Ltd through the Moodle has several features considered typical of an e-Learning platform, plus some original innovations (like its filtering system). Moodle is very similar to a learning management system. Moodle can be used in many types of environments such as in education, training and development, and business settings.

Some typical features of Moodle are:

- Assignment submission
- Discussion forum
- Files download
- Grading
- Moodle instant messages
- Online calendar
- Online news and announcement (College and course level)
- Online quiz
- Wiki

Developers can extend Moodle's modular construction by creating plugins for specific new functionality. Moodle's infrastructure supports many types of plug-ins:

- activities (including word and math games)
- resource types
- question types (multiple choice, true and false, fill in the blank, etc.)
- data field types (for the database activity)
- graphical themes
- authentication methods (can require username and password accessibility)
- enrolment methods
- content filters

**Dokeos**

Dokeos is an open-source online learning suite. It provides all the features needed for e-Learning and blended learning management: from Authoring to Reporting .Overview of features of Dokeos is given in Figure 2. Dokeos supports converting Office documents into Learning Paths, offers user synchronisation with HR management systems such as Oracle and SAP.


Figure 2: Overview of Features of Dokeos (Source: http://www.dokeos.com/en/products)

**SAKAI**

SAKAI is a robust system supporting over 4 million educational users to enhance collaborative teaching, learning and research. The Sakai Collaboration and Learning Environment (CLE) represents the values and SAKAI of the community of educators that have contributed to the software. SAKAI particularly aimed at universities and backed by the Sakai Foundation which manages relationships with educational and commercial supporters. Main features of SAKAI are listed below (http://www.sakaiproject.org).

- Academic collaboration
- Research collaboration
- Portfolios
- Enterprise reliability
- Open pedagogy
- Open standards

**eFront**

eFront is developed by EPIGNOSIS Ltd. The company offers open-source as well as commercial editions of eFront. Community Edition is open-source and free to use. eFront is developed to support e-Learning by assisting the process of creating effective distant learning communities. eFront offers attractive icon-based user interface and is capable of fulfilling a wide range of learning requirements by offering many tools for content management, quizzes, assignments, reports, chat, forums, surveys, etc. The eFront is user-friendly, extensible and suitable for both academic and company use. eFront is built around three basic type of users, namely Students, Professors and Administrators (in an Enterprise environment, the roles are Trainee, Trainer, and Administrator respectively). Each type of user can have sub-types with fewer privileges from the main user. It is also possible to interchange roles for each user for different courses.

# Appendix 5.2: A comparison of the main features and tools of KMS platforms

| | Tools and Features | Office 365 | Google Apps | Hyper Office | LotusNotes | BlackBoard/WebCT | Desire2Learn 10 | KEWL | ANGEL | eCollege | Moodle 1.8 | Claroline 1.6 | Dokeos 2.2 | OLAT 7.0 | Sakai 2.3.1 | A Tutor 2.1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Document library | Y | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| 2 | Workflows | Y | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| 3 | Bookmarks | Y | Y | Y | Y | N | Y | Y | Y | Y | N | Y | N | N | Y | Y |
| 4 | Five layers of security | Y | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| 5 | Authorisation Management | Y | N | N | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 6 | 99.9% uptime guaranteed service availability | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 7 | Wiki | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 8 | Glossary | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 9 | MS Office Web Apps | Y | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| 10 | Learner Tracking | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y |
| 11 | Task Lists | Y | N | N | N | N | N | N | N | N | N | N | N | N | N | N |
| 12 | Orientation/Help | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | Y |
| 13 | Multi lingual support | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 14 | Versioning and archiving | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 15 | Calendar/Progress Review | Y | Y | Y | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 16 | 24/7 Access | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 17 | Portfolios | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y |
| 18 | Multimedia support | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 19 | Cloud Based and Offline Access | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 20 | Provide users anywhere-access | Y | Y | Y | Y | Y | N | N | N | N | Y | N | N | N | N | N |
| 21 | Discussion Forums | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 22 | Discussion Management | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 23 | File Exchange | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 24 | Internal Email | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 25 | Online Journal/Notes | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | Y | Y | Y |
| 26 | Real-time Chat | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 27 | Whiteboard | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | N | N | Y | Y | Y |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28 | RSS Feed | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 29 | Team Collaboration | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y |
| 30 | Web Conferencing | Y | Y | Y | Y | Y | N | N | N | N | N | N | N | N | N | N |
| 31 | Instant Messaging | Y | Y | Y | Y | Y | N | N | N | N | N | N | N | N | N | N |
| 32 | Community Networking/Social Media | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 33 | Course Management | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 34 | Accessibility Compliance | Y | Y | Y | Y | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 35 | Content Sharing/Reuse | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | Y | Y | Y |
| 36 | Searching Within Course | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y |
| 37 | Course Templates | Y | N | N | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 38 | Customised Look and Feel | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 39 | Instructional Design Tools | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 40 | Instructional Standards Compliance | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 41 | Work Offline/ Synchronize | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | Y | Y | Y |
| 42 | Test Types | Y | N | N | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 43 | Automated Testing Management | Y | N | N | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 44 | Automated Testing Support | Y | N | N | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 45 | Online Marking Tools | Y | N | N | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 46 | Online Gradebook | Y | N | N | N | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| 47 | Constructivist Learning Model | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |

# Appendix 5.3: Mapping of the quality attributes and features of KMS platforms

| Quality attribute | Supporting Tool/feature in KMS platforms |
|---|---|
| Content quality -How good the KMS platform is in terms of its output | |
| Content representation | Course management tools, Instructional Design Tools, Multimedia Tools, File Exchange, Document Library |
| Consistency | Course Templates |
| Flexibility | Cloud based and Offline access to the tutorial |
| Interactivity | Multimedia tools, wiki, Glossary |
| Learning model | Constructivst Learning Model |
| Clarity | Course Templates, Instructional Design Tools, searching within course |
| Understandability | Course Templates, Notes, Glossary, wiki, |
| Tutorial structure | Document library, search, Notes |
| Up-to-datedness | Calendar, User Tasks, version history of tutorials and archiving |
| Learner assessment quality | Question types, Grading , student tracking |
| Well-organised | Document library, Content management tools, Wikis, Notes, searching within course |
| Completeness | Course management tools, Document Library |
| Relevancy | Course management tools |
| Accuracy | Course management tools |
| Teaching and learning | Course management tools, student tracking tools, Glossary, Document Library |
| Reliability | Content sharing/reuse (Error free upload download and sharing of tutorials) |
| Information contextual quality | Content management tools, glossary, wiki, document library |
| Self-regulated learning | Personal pages, web-based document editing and viewing, content sharing/reuse |
| Usefulness | Instructional design tools, |
| Academic performance | Course management tools, student tracking, Grade book, Automated testing support, test types, online marking tools |

| Quality attribute | Supporting Tool/feature in KMS platforms |
|---|---|
| Platform quality -How good the KMS platform in terms of its operational characteristics | |
| Easy to use | Familiar user interface , document library, book marks, work flows |
| Security | Authorisation management, five layers of security (data, application, host, network, and physical). |
| Reliability | 99.9% uptime guaranteed service availability |
| Usability | Wiki, Glossary, MS Office Web Apps , Student tracking, Task lists |
| Help option available | Help |
| User friendly | Book marks, MS Office Web Apps, task lists, Familiar user interface , Multilingual support |
| Well-organised | Calendar, book marks, versioning and archiving |
| Availability | 24/7 access |
| Personalisation | Book marks, task lists, personal user profiles |
| Interactivity | Multimedia Tools, Wiki, Glossary |
| Accessibility | Cloud based and offline access |
| Response time | Quick responses |
| Easy to communicate | Email, chat, forum, announcements, RSS feed, team collaboration tools, file exchange, web conferencing, Instant messaging, social media, Whiteboard |

| Quality Attribute | Supporting Tool/feature in KMS platforms |
|---|---|
| User satisfaction -To what extent users are satisfied | |
| Efficiency and effectiveness | Due to all of the features of KMS platform |
| Intention to use | Due to all of the features of KMS platform |
| Learner attitudes toward KMS platform | Due to all of the features of KMS platform |
| Enjoyable experience | Due to all of the features of KMS platform |
| Learners' study habits | Cloud based and offline access |
| Motivation/commitment/self esteem | Due to all of the features of KMS platform |
| Communication with fellow learners | Email, chat, forum, announcements, RSS feed, team collaboration tools, file exchange, web conferencing, Instant messaging, social media |
| Time management/time on task | Calendar , Task Lists, Automated Tests, Provide users anywhere-access to their email, assignments, and calendars on devices (including PC, Mac, Windows Phone, iPhone, Android, and Blackberry) |

# Appendix 5.4: Features of the KMSS prototype used to represent quality attributes

**Content quality attributes**

- *Content representation:* Content is presented clearly from basics of databases to creating a database with examples to easily understand with less time. Transcript is given to use as an additional source to follow while learning the content or to follow after completing the tutorial.
- *Consistency:* A template with colours, images, buttons and navigation suitable for a learning content is used. Consistent words and phrases are used in the content and narration.
- *Flexibility:* Users can play the video with the tools in a player that supports MP4, control buttons, navigation tools and transcript in the video (explained in the video in using the player section). Alternatively same content is given as a PowerPoint presentation for the users to use according to the preferred method of learning.
- *Interactivity:* For interactivity in tutorial; images, buttons, tabs, links, navigation, animations, text, narrations, responses to user actions and quizzes are used appropriately.
- *Learning model:* Constructive learning model is used for achieving intended learning outcomes (ILOs) of the tutorial through teaching and learning activities (TLAs) and assessment tasks (ATs).
- *Clarity:* The tutorial is structured in a way to self learn with clear instructions. Simple examples, demonstrations and narrations provide clear explanation of the tutorial. Transcript is given as an additional resource to understand the tutorial clearly.
- *Understandability:* Tutorial is explained step by step with demonstration for each concept explained. Summary and quizzes at the end of each section are given to assure that the learner understand each section.
- *Tutorial structure:* Tutorial is structured according to the principles of experiential learning style and constructive alignment by giving teaching and learning activities (TLAs) to achieve intended learning outcomes(ILOs). Entire tutorial is divided in to five sections with linear navigation for completing the entre tutorial. Learner can go back and learn the contents already learned.
- *Up-to-datedness:* Up to date content, examples, version of software and objects in the video and KMSS are used.
- *Learner assessment quality:* Quizzes at the end of each section and at the end of entire tutorial, practical exercises and review of answers to quizzes and practical exercises are used. Different types of questions in quizzes and practical exercises are used.
- *Well-organised:* Content of the tutorial is organised in a way that can be followed easily. Entire tutorial is divided in to five sections with linear navigation for completing the entre tutorial. Learner can go back and learn the contents already learned.
- *Completeness:* Complete information is given for learning from basics to creating a database and reviewing the learned concepts in the summary and by taking a quiz in each section and MySQL statements to try it yourself.
- *Relevancy:* Information relevant to learning outcomes as well as using the video is given.
- *Accuracy:* Accurate content for the tutorial is given and the results of the commands executed indicate the accuracy of the content.
- *Teaching and learning:* Experiential learning style is used in the video by considering learner centred self learning of the tutorial.

- *Reliability:* The video can be downloaded and played without errors. Each component in the video is tested for reliability.
- *Information contextual quality:* Suitable examples are given to explain the content in the tutorial and appropriate questions are given in quizzes to revise the tutorial.
- *Self-regulated learning:* This video is created for self learning through a KMSS. Clear instructions for using the video and other components in the KMSS are given for self regulated learning.
- *Usefulness:* Tutorial provided useful information to apply for creating a database and new experience to motivate self learning using a KMSS.
- *Academic performance:* At the end of the tutorial learner is given practical exercises, a quiz, and a test to apply the knowledge gained through this video. Academic performance is evaluated based on the learner performance for the quiz and the practical test.

**Platform quality attributes**

- *Easy to use:* A familiar user interface with single log in to KMSS platform, e-mail and questionnaire surveys were given. Learner can access KMSS from anywhere as online and offline according to the preferred learning style.
- *Security:* Security of data is assured by giving authorised access to users' data in the KMSS and multi-layer security is provided in KMSS.
- *Reliability:* Data in the KMSS is reliable and the cloud based storage is provided for reliable storage of users' data.
- *Usability:* All the components in the KMSS are usable for teaching and learning as a self learner.
- *Help option:* Help on how to use the platform as well as its components are given. 24/7 help is available in KMSS.
- *User friendly:* User interface of KMSS is designed for novices to learning. Guidance for using each component is provided and no any prior knowledge required for using KMSS.
- *Well-organised:* All the components of the KMSS are well organised according to principles of instructional design and human computer interaction.
- *Availability:* KMSS is available for learner to use at any time as online and off line access. Supported with Microsoft Office, cloud based storage and outlook web application.
- *Personalisation:* Personalised information related to the learner is given and security levels are used according to user category.
- *Interactivity:* KMSS is designed with interactive features though audio, video and text based interactive features such as video tutorials, transcripts and text responses.
- *Accessibility:* KMSS can be accessed in any internet browser which support widely used Microsoft products.
- *Response Time:* Quick responses are provided for users' actions in KMSS.

**User Satisfaction**

- *Efficiency and effectiveness:* KMSS is designed with additional features for learning such as calendar, blog, discussion board, instant messaging for improved efficiency and effectiveness in learning using KMSS.
- *Intention to use:* Features in KMSS were used to enhance learners' intension to use KMSS as a self learning platform.
- *Learner attitudes towards KMSS:* Feedback on quality of the KMSS discusses on discussion forums, gathered through questionnaire survey was used to
- *Enjoyable experience:* Features for communication with fellow students, wikis, blogs, social networking and outlook were used in KMSS to provide enjoyable experience to learners.
- *Learners' study habits (e.g. self learning):* Features of the KMSS for self learning were enhanced in order to facilitate self learning.
- *Motivation/commitment/self esteem:* Learner participation for learning through KMSS was raised through interactive activities designed in KMSS.
- *Communication with fellow learners:* Various methods for communication using discussion board, wiki, blogs, outlook, announcements and social networking are provided in KMSS.
- *Time management/time on task:* Calendars, reminders through e-mail, notebook, and section by section completion of tutorial and online and off line access to components were provided as facilities for managing learners' time.

The above mentioned quality features in prototype helps to provide content quality, platform quality and user satisfaction quality attributes in combination with all components of the KMSS.

# Appendix 5.5: Components of the KMSS prototype

**URL**

URL: https://keeleKMSS.sharepoint.com/teams/db

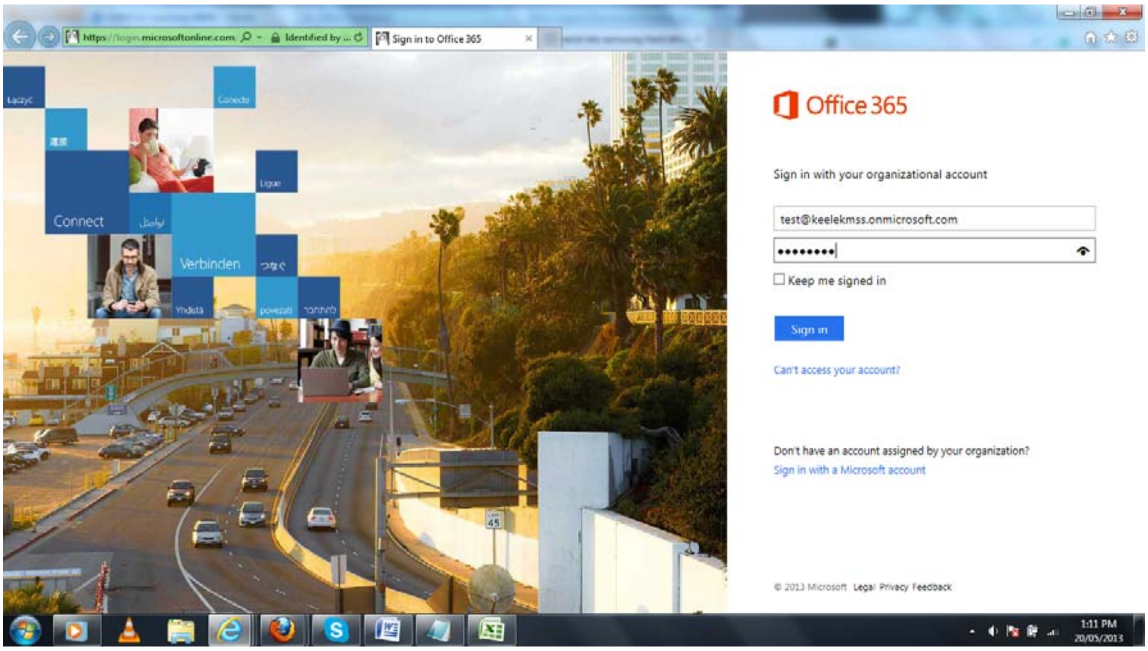
By giving this URL in the internet browser users will get login page.

**Login Page**

In this platform a single log on for all the components of the site is given in a familiar user interface.

Users are given user name and temporary password.

In the first login users can create a password.




**Home Page**

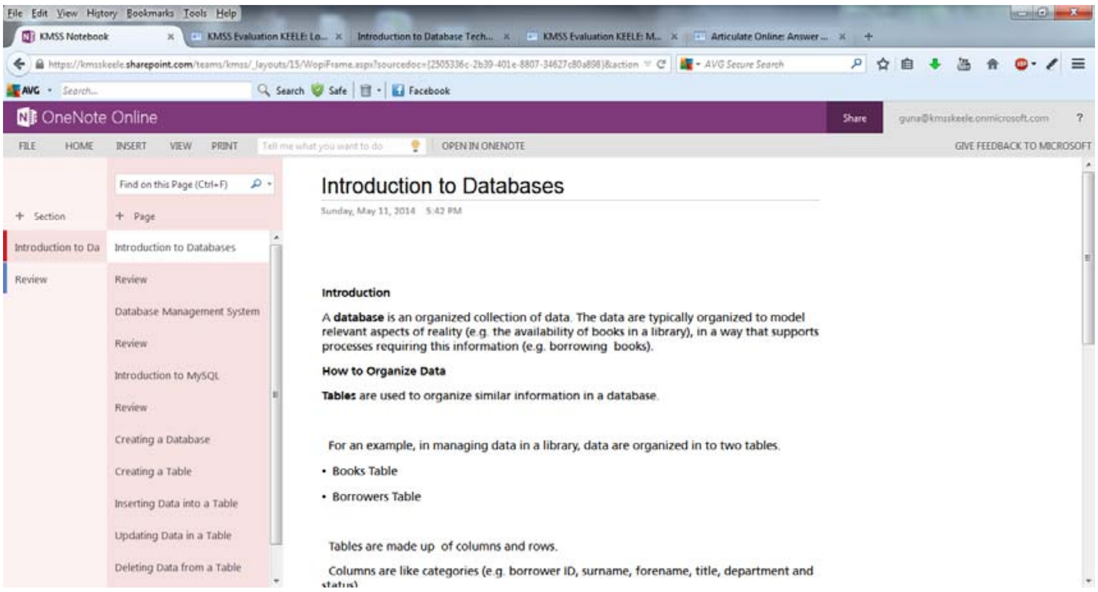
Homepage is designed in a familiar structure with menus in left side of the screen and in the top ribbon. Links are given for easy navigation to the components of KMSS. Body of the Home page is used to give the main tutorial content and links to related documents. Main sections of the body of the home page are:

- Learning Outcomes
- Method of Assessment
- Assessment Criteria
- Links to learning materials, practical test, practical exercise and quiz

For the effectiveness of learning, tutorial content was designed according to the constructivist learning model and particularly by considering constructive alignment described in Chapter 4. In order to achieve learning outcomes, tools in Microsoft Office 365 for interactivity, learner engagement to the tutorial, collaboration, social networking and communication were used.

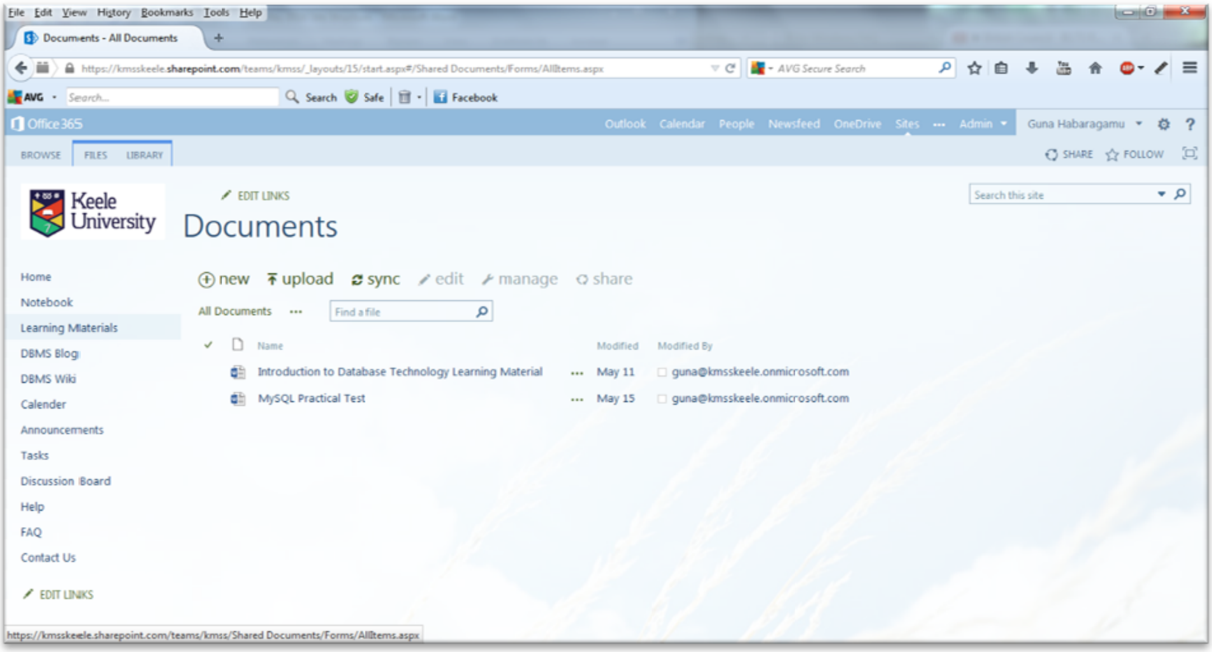

## Notebook

Notebook act as a digital notebook that allows to capture and share pictures, web pages, notes and voice memos. Users can give quick editorial comments and for highlighting important features.



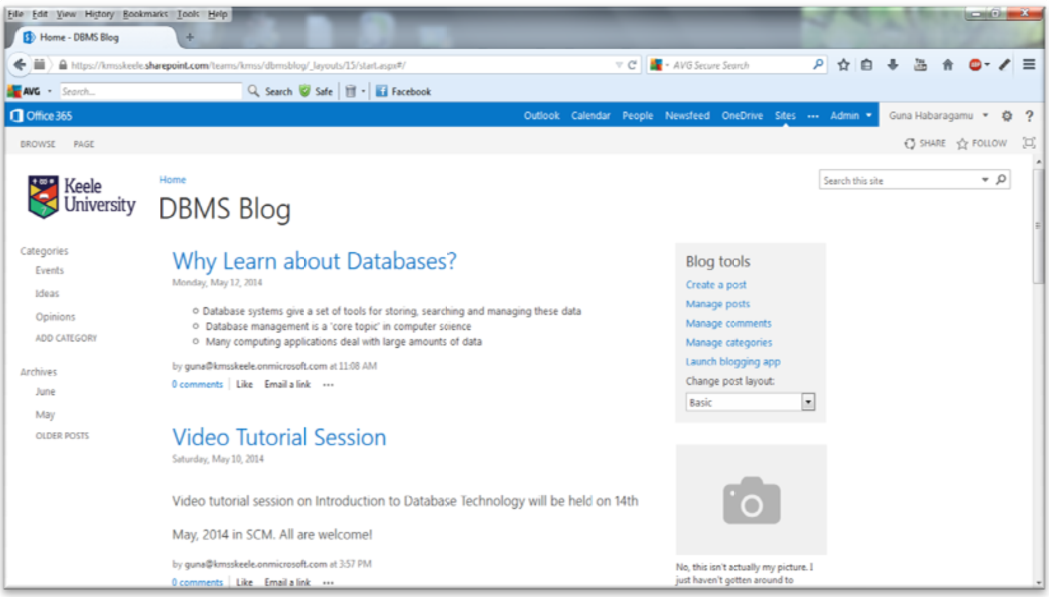
### Learning Materials

Learning Material section act like a document library that users can view and download documents. All the additional notes, exercises and quizzes in this KMSS are given in Learning Materials section with links in the home page.



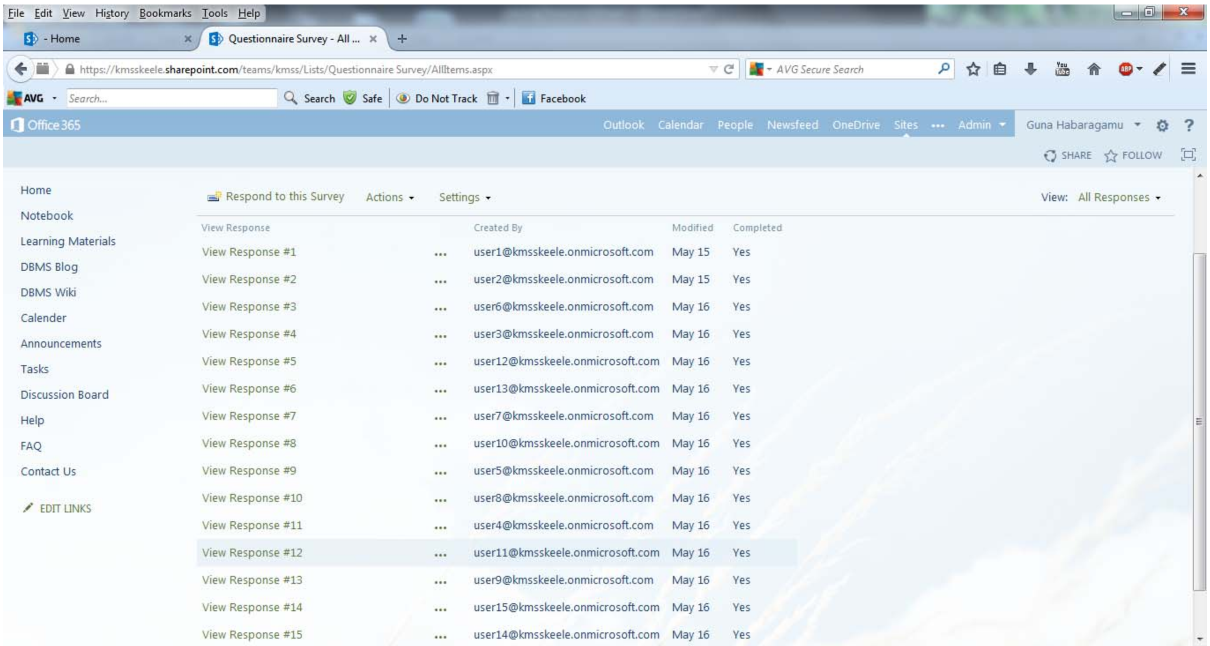

### Blog

Blog in this KMSS act as a method of social networking and a means of sharing knowledge. Users can create, manage and add categories to blog. In this KMSS blog is categorised in to events, ideas, opinions and can add more categories. Other features of the blog are archiving, RSS feed and alerts to users.



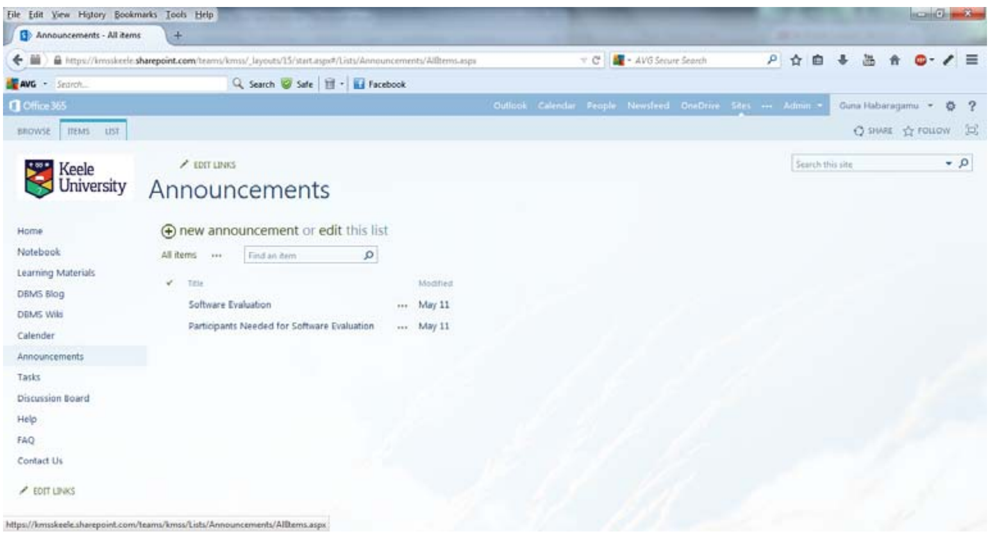
## Survey

A survey is a special kind of list that enables the owner to create questions, multiple people to respond to the questions, and the results to be summarised. In this KMSS Survey is used get the users feed back to the questionnaire to rate the features of the KMSS. Summary of responses are given graphically and further analysis of responses can be done using Microsoft excel.



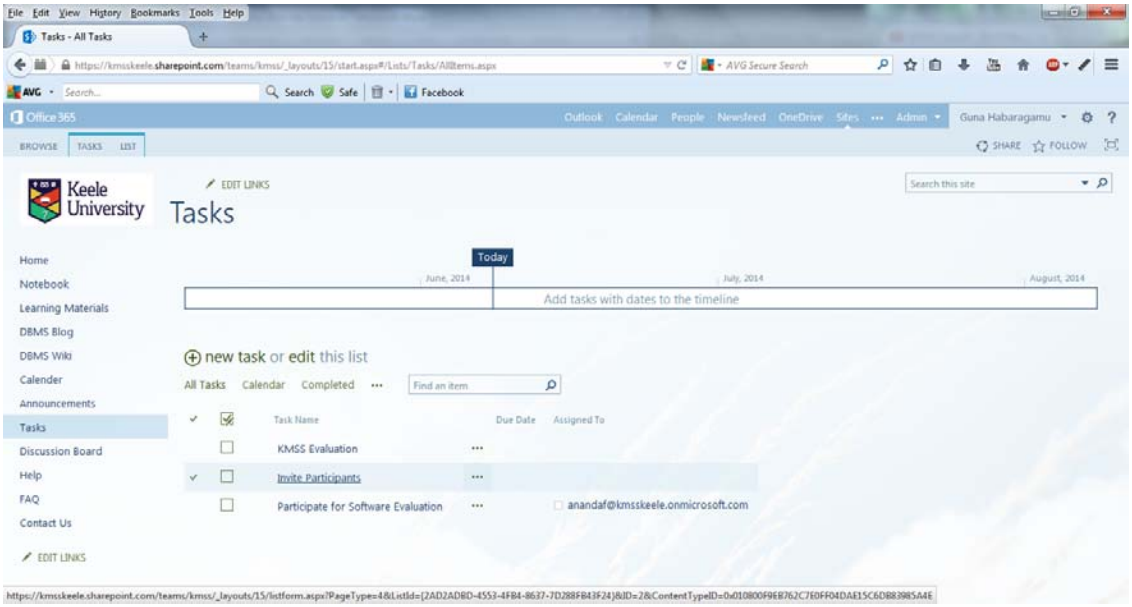

## Announcements

Announcements are used to share news and status and to provide reminders. Announcements support enhanced formatting with images, hyperlinks, and formatted text. Users can add announcements to the list and the person who added the announcement is visible to other users.



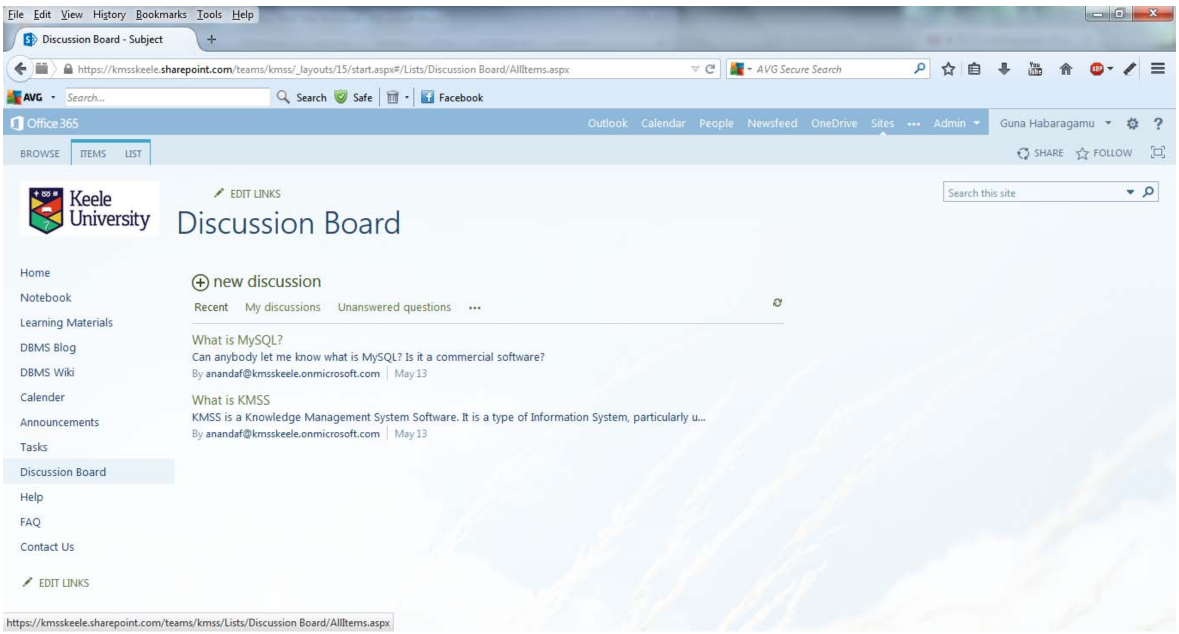
## Tasks

Task list is used to track information about projects and other to-do events in a group. Tasks can be assigned to people, as well as track the status and percentage complete as the task moves toward completion.



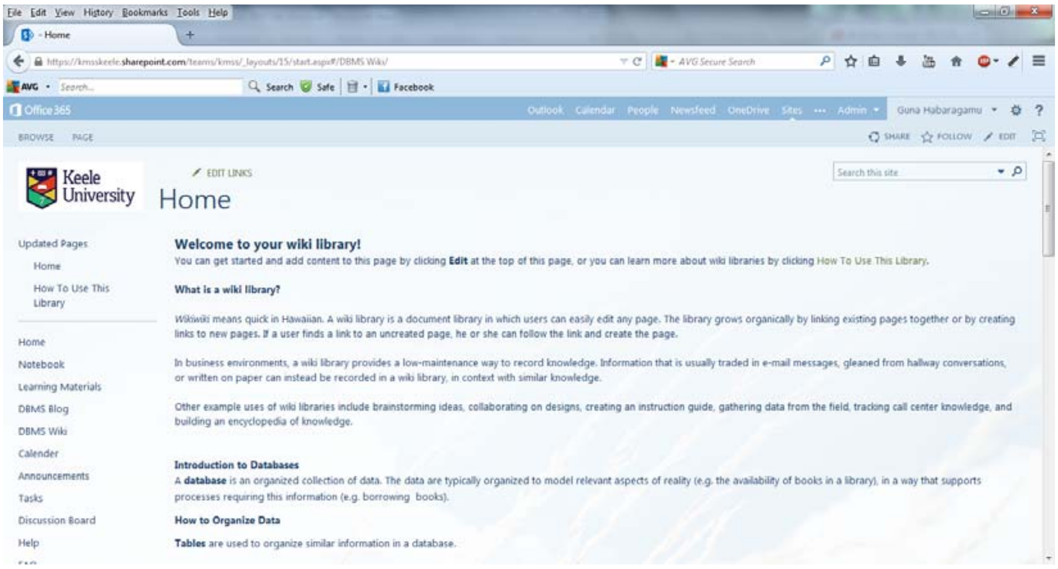

## Discussion Board

Discussion board provide a central place to record and store team discussions that is similar to the format of newsgroups. In this KMSS users can add new discussions and view the archived previous discussions.



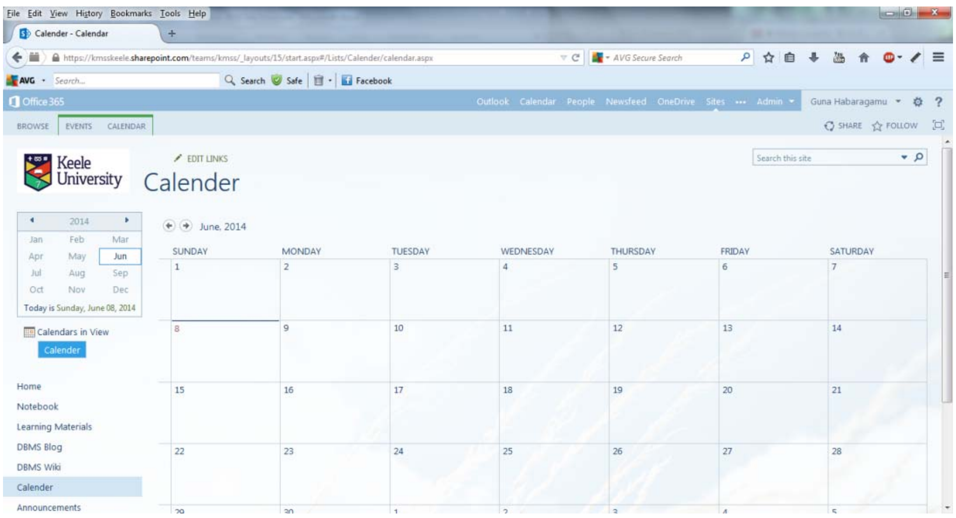
## Wiki

Wiki is a library used to create a collection of connected wiki pages in KMSS. A wiki enables multiple people to gather information in a format that is easy to create and modify. Users can also add wiki pages that contain pictures, tables, hyperlinks, and internal links, to your library. In this KMSS wiki is used to store information related to learning Database Management Systems.



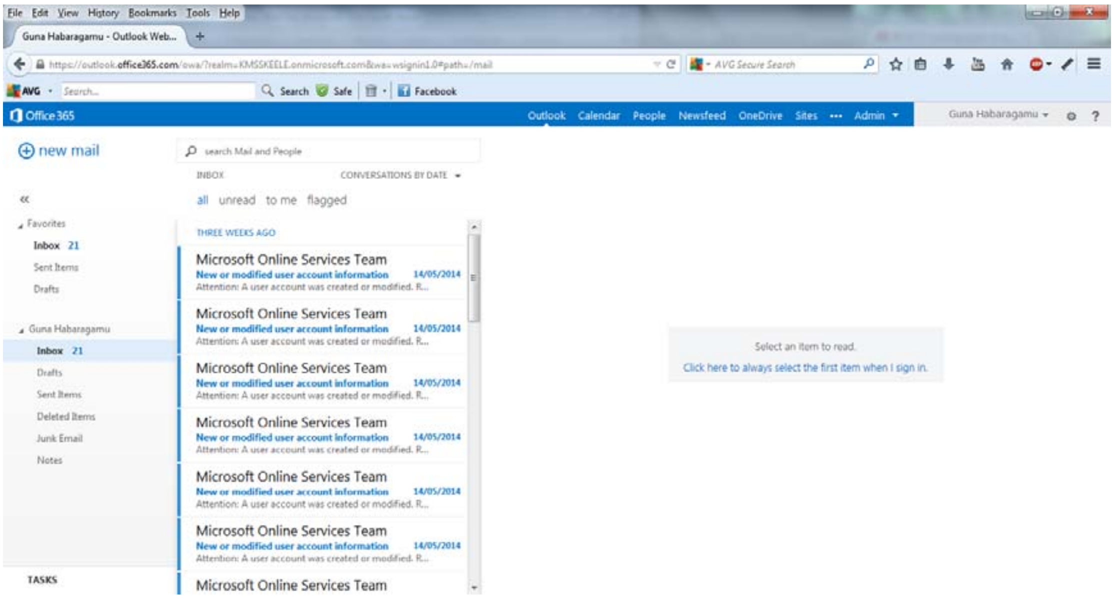

## Calendar

Calendar can be used for all of the team's events or for specific situations, such as school holidays. A calendar provides visual views, similar to a desk or wall calendar, of team events, including meetings, social events, and all-day events. It can also be used to track team milestones, such as deadlines or product release dates that are not related to a specific time interval. If users are using an email or calendar program that is compatible with SharePoint technologies, users can view and update calendar from site while working in the other program. For example, users can compare and update calendar on the site with dates from users Outlook calendar, by viewing both calendars side-by-side or overlaid with each other in Outlook.



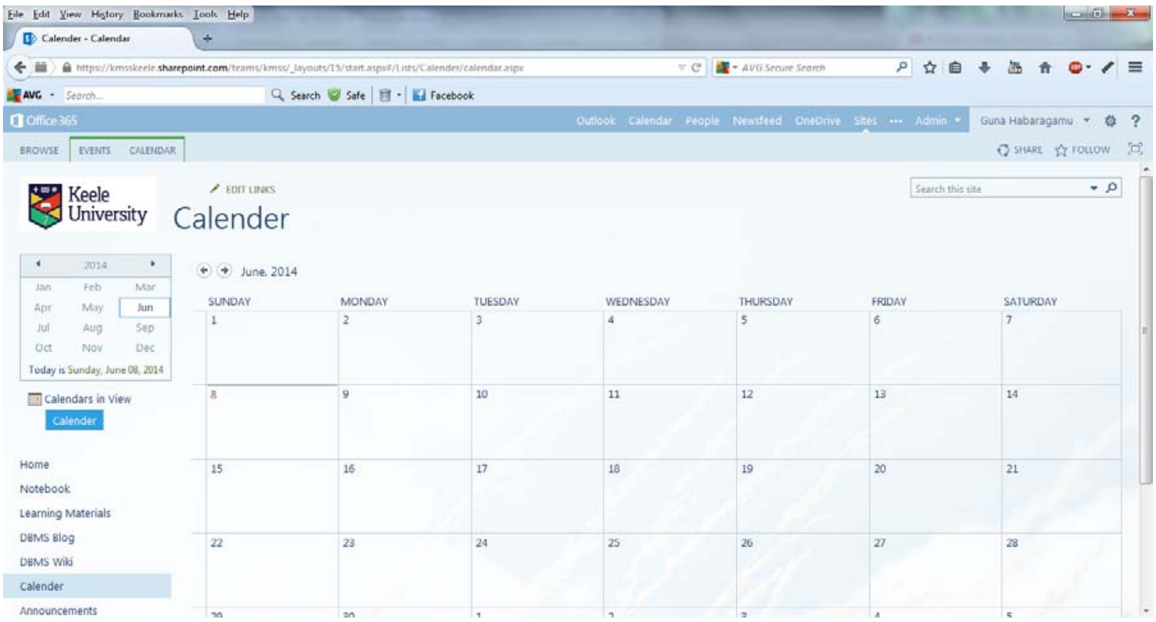
## Outlook

Outlook Web App (OWA) provides web-based access to organisation's hosted Exchange services, including email, contacts, calendar, and tasks. It has familiar components of a mail system so that users can easily communicate and collaborate through KMSS platform.



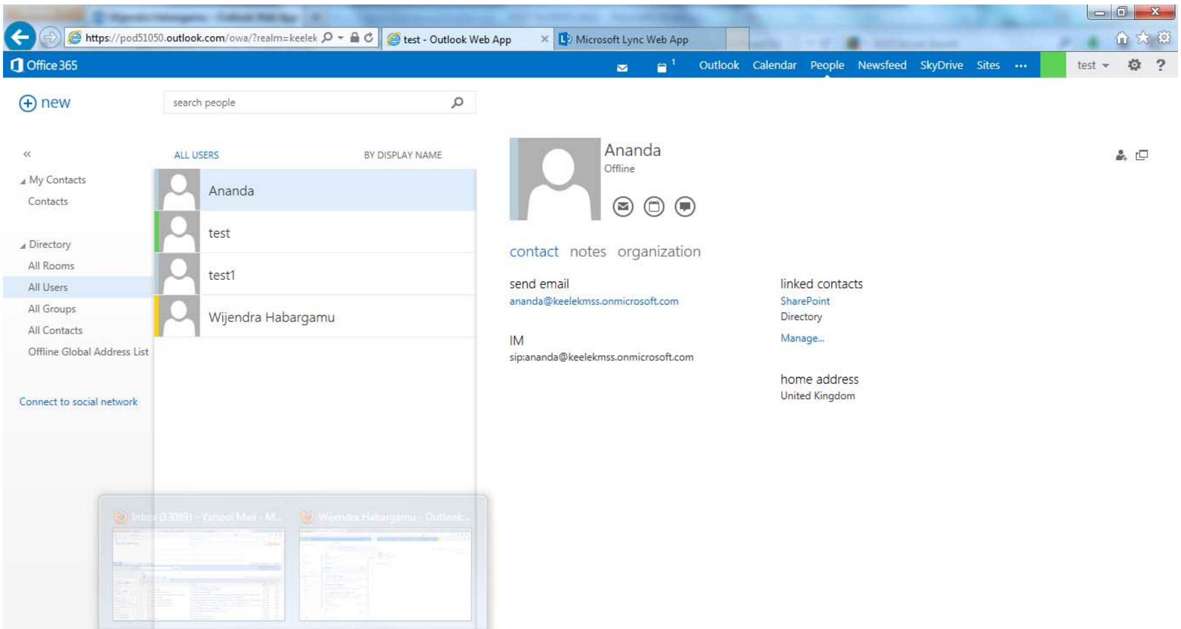

## Calendar

The calendar in top ribbon can be personalised by users to create scheduled activities. This calendar lets users to create and track appointments and meetings. Users can create multiple calendars, link to other people's calendars, and even share user's calendar with other people in the organisation. Users can view the calendar four different ways: Day, Work week, Week, and Month. A meeting that use has been invited to will show the organiser and include links to respond to the invitation. If the organiser has included an online meeting invitation, user will see a link to join the meeting.



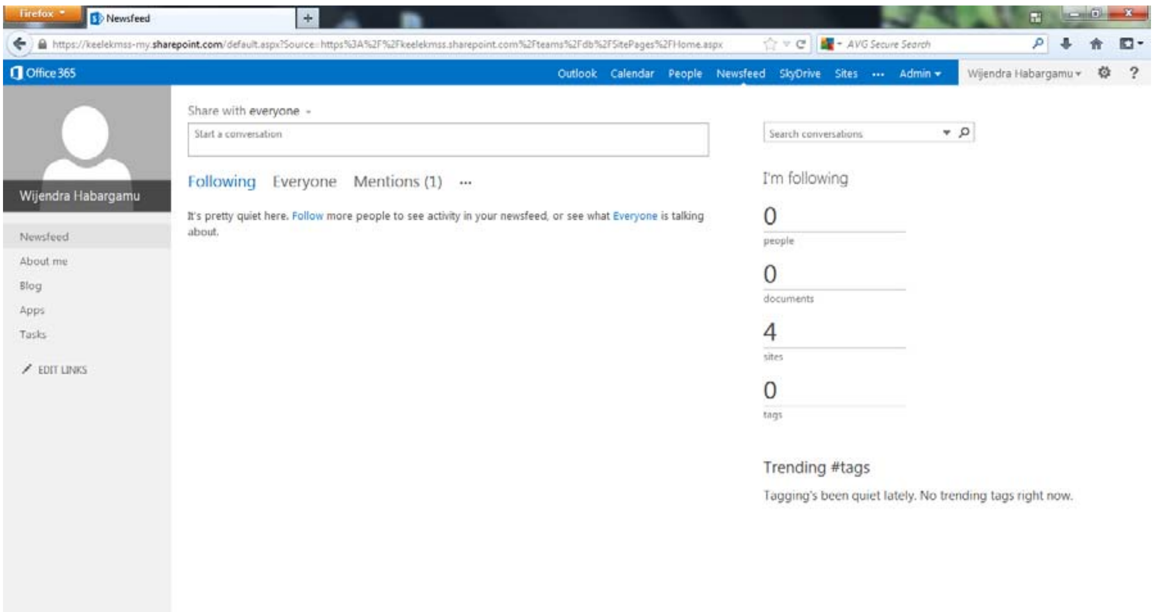
## People

People section on the top ribbon is where user's personal contacts are stored and where user can view any address books that have been set up.




## Newsfeed

Newsfeed is a feature in KMSS used to stay in tune with conversations among user's workmates, and to see other updates about their activities. The "Following" view of the newsfeed generally contains items that users are likely to find most relevant and interesting. Here users primarily see posts created by people users are following, and posts pertaining to other content users are following, such as tags and documents. In addition to the "Following" view, users can view the "Everyone" view, the organisation-wide newsfeed.

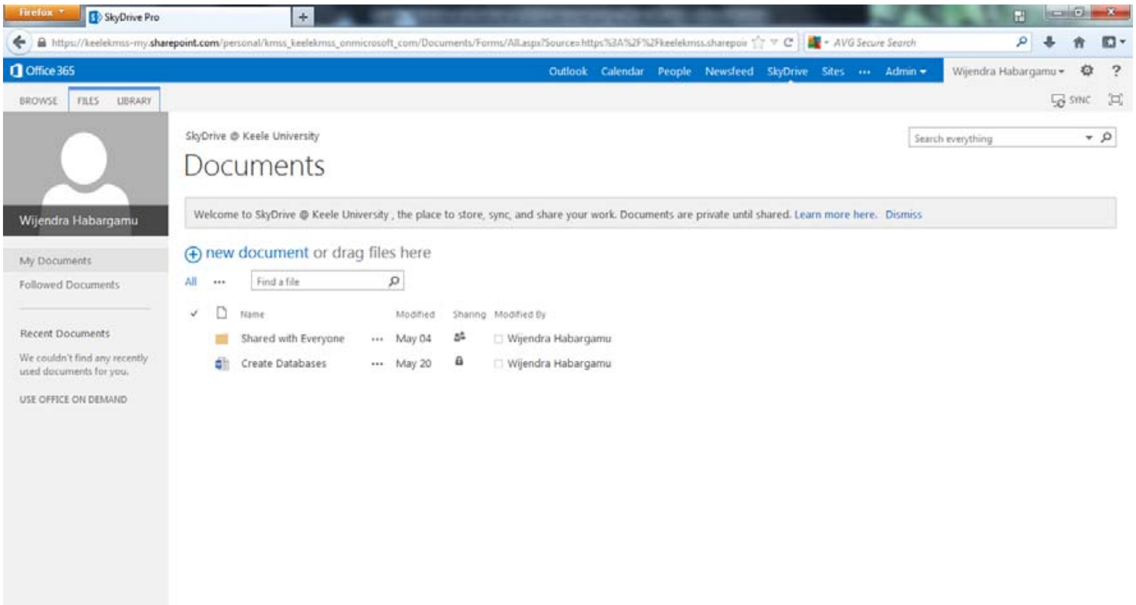


**SkyDrive**

SkyDrive is user's professional library; the place to keep work documents and other files. When users store files on SkyDrive, only user can see them, but user can easily share them with co-workers and access them from mobile devices. User's files are safely kept in the cloud with SharePoint Online.

SkyDrive in KMSS lets users to:

- Store and organise private documents and other files in a secure location in the cloud
- Share files and folders with other people in your organisation and give them permission to review or edit the content.
- Synchronize files and folders in SkyDrive and other SharePoint libraries with computer or mobile devices, so users can access content offline.




**Presentation of the tutorial**

In this KMSS tutorial is delivered in the main body of the homepage with easy navigation to the video, PowerPoint presentation and additional learning materials given in learning materials section of the Home page.

After completing the tutorial learners will be given learning activities to carry out in MySQL.

Step by step guidance is given on how to use MySQL to create a database and a table in a database. Practical exercises on creating, retrieving, updating and deleting data from a table are given.

At the end of the practical session learner was given a practical test and a quiz on the tutorial.

Instructions will be given on how to upload answers to the practical test and quiz.

## Home Page of Tutorial


## Using the Player

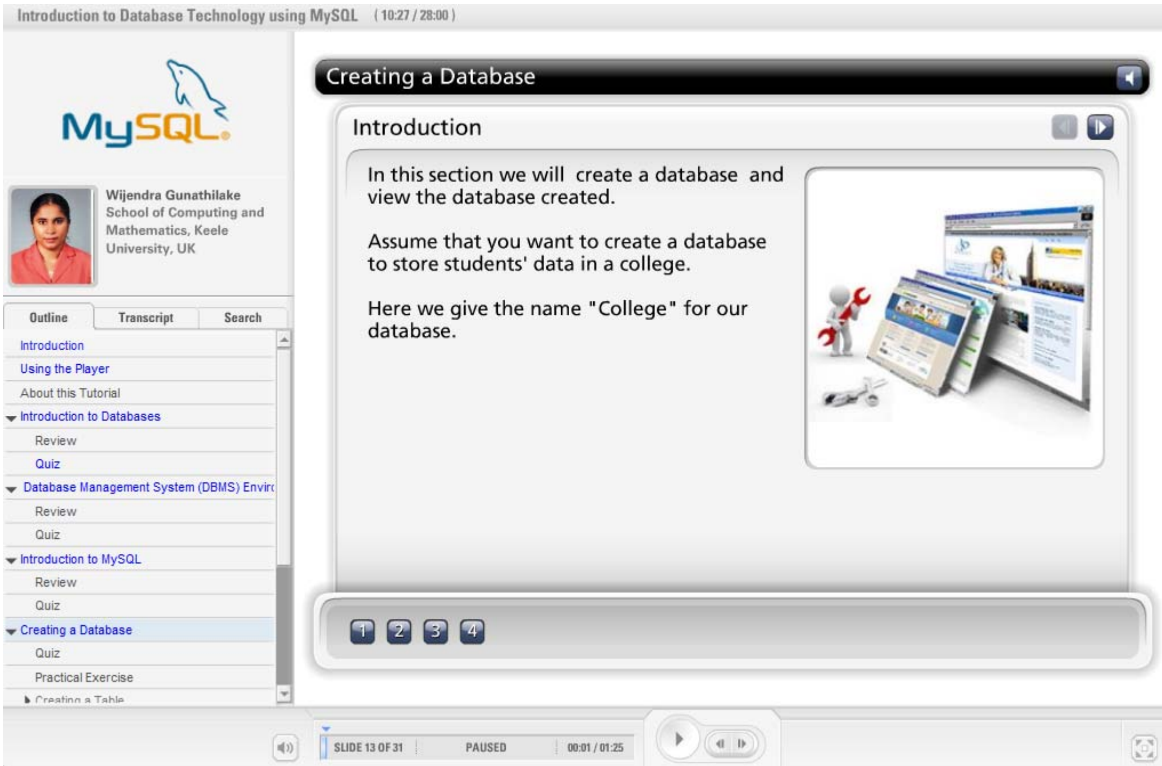
## Main Sections of tutorial

## 1. Introduction to Databases

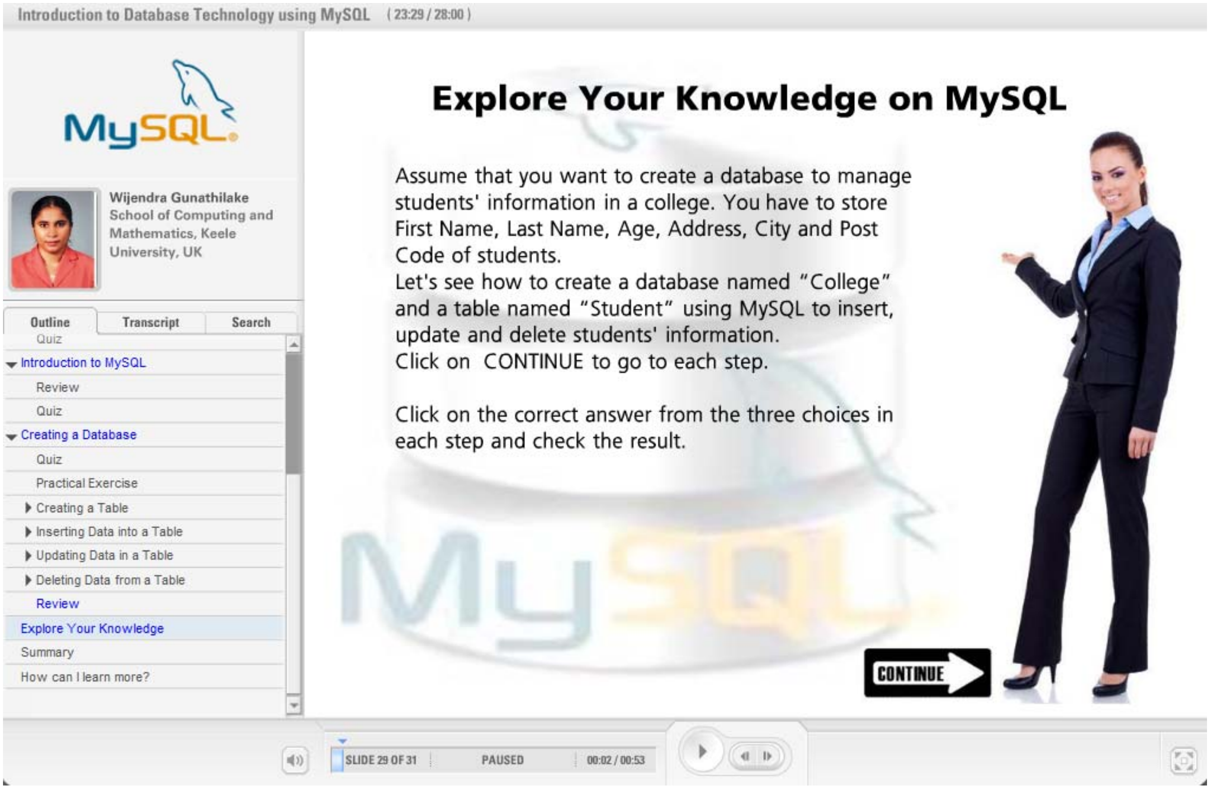

## 2. Database Management System Environment

## 3. Introduction to MySQL


## 4. Creating a database



## 5. Quiz




## Information for Evaluation of KMSS

**About KMSS**

KMSS (Knowledge Management System Software) is developed for learning Introduction to Database Technology for those who are new to learning Database Technology.

Activities given for you are:

- **video tutorial**
- **quiz**
- **Practical test**

Finally you will be given a **questionnaire** to rate the features of KMSS.

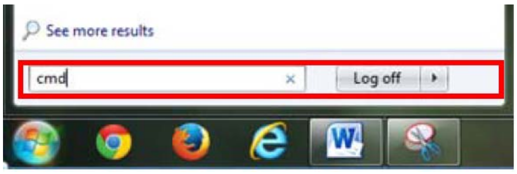
## Log in details for KMSS

**URL** https://KMSSkeele.sharepoint.com/teams/KMSS

**Username** user1@KMSSkeele.onmicrosoft.com

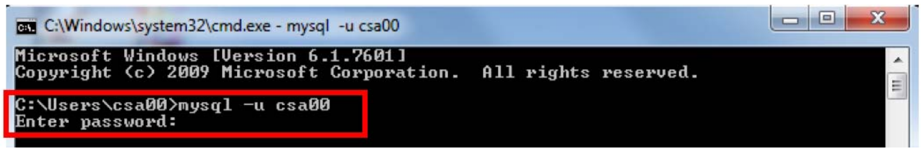
**Password** KMSS1@ab

## Log in Details for MySQL

Open Command prompt: Start-→ type cmd 


Log on to MySQL: mysql(space)-u(space)username

Enter Password:




e.g. >mysq –u user1

Enter Password: NeMNMk

**Username** user1

**Password** NeMNMk

**<u>Log in Details for Quiz</u>**

**Username** user1@KMSSkeele.onmicrosoft.com

**Password** quiz

# Appendix 5.6: Assessment tasks in the KMSS prototype

**MySQL Practical Exercise**

**Instructions:**

- ***Open MySQL and execute MySQL commands for questions 1 to 5.***
- ***Copy answers (results after executing commands) from the MySQL Screen and Paste into the sections given in this document.***
    - ***Copy your answer using the keys: ALT+Prt Sc***
    - ***Paste your answer to space given below in this document: right click on the space given for answer and Paste***
- ***Send your answers by e-mail to w.gunathilake@keele.ac.uk***

Assume that you have just started a new company named ABC Pvt. Ltd. It is time to hire some employees. Assume that you need to create a database named **"Employee"** to manage employee details. Create a table named **"EmpDetails"** that contain the following information about your new employees: First Name, Last Name, Title, Department and Experience.

Use appropriate MySQL statements to complete the following exercises. You can use learning materials and video tutorial in KMSS as references.

**1. Create Database**

Create a database named **"Employee"**

Use **"Employee"** database

*Copy answer (results after executing commands) from the MySQL Screen and Paste into the* ***space given for Answer to Create Database*** *in this document.*

**2. Create Table**

Create a table named **"EmpDetails"**. Field names, Data Types and length of field are given below.

| Field Name | Data Type | Length |
|---|---|---|
| FirstName | VARCHAR | 30 |
| LastName | VARCHAR | 30 |
| Title | VARCHAR | 20 |
| Department | VARCHAR | 20 |
| Experience | INT | 3 |

Use SHOW TABLES statement to view the table you created in **"Employee"** database.

*Copy answer (results after executing commands) from the MySQL Screen and Paste into the* ***space given for Answer to Create Table*** *in this document.*

3. **Insert Data**

Your first three employees are the following. Enter these employees into **“EmpDetails”** table.

| FirstName | LastName | Title | Department | Experience |
|---|---|---|---|---|
| Rob | Waber | Business Analyst | IT | 3 |
| Nick | Smith | Accountant | ACC | 4 |
| Sandra | Manley | Secretary | HR | 2 |

Use SELECT statement to view the details in the **“EmpDetails”** table.

*Copy answer (results after executing commands) from the MySQL Screen and Paste into the **space given for Answer to Insert Data** in this document.*

**4. Update Data**

Sandra just got married to Bob Williams. She has requested that her last name be updated to Williams. Update Sandra’s details in **“EmpDetails”** table.

After update data, use SELECT statement to verify your changes in **“EmpDetails”** table.

*Copy answer (results after executing commands) from the MySQL Screen and Paste into the **space given for answer to Update Data** in this document.*

**5. Delete Data**

Nick Smith just quit, delete his record from the **“EmpDetails”** table.

Use the SELECT statement to verify your delete from **“EmpDetails”** table.

*Copy answer (results after executing commands) from the MySQL Screen and Paste into the **space given for answer to Update Data** in this document.*

--------------------

**Your Answers to Questions**

**USER NAME:**

**1. Answer to Create Database**

2. **Answer to Create Table**

3. **Answer to Insert Data**

**4. Answer to Update Data**

**5. Answer to Delete Data**

# Appendix 5.7: Summary of responses to the questionnaire survey-from Keele University, UK

| | | Positive Responses | | | Neutral Responses | | Negative Responses | | |
|---|---|---|---|---|---|---|---|---|---|
| **Q. No.** | **Question** | **SA** | **A** | **% of SA and A** | **N** | **% of N** | **D** | **SD** | **% of D & SD** |
| | **Content quality** | | | | | | | | |
| A1 | The learning outcomes of the tutorial are stated clearly | 20 | 4 | 85.71 | 3 | 10.71 | 0 | 1 | 3.57 |
| A2 | The tutorial is easy to follow | 21 | 4 | 89.29 | 1 | 3.57 | 1 | 1 | 7.14 |
| A3 | The tutorial is interactive (e.g. learning using video, audio, animations and simulations etc.) | 19 | 4 | 82.14 | 3 | 10.71 | 1 | 1 | 7.14 |
| A4 | The tutorial content is up-to-date (e.g. content, examples, MySQL version, and references) | 18 | 6 | 85.71 | 3 | 10.71 | 0 | 1 | 3.57 |
| A5 | Consistent colours, images, tabs, words and phrases are used in the tutorial | 19 | 4 | 82.14 | 4 | 14.29 | 0 | 1 | 3.57 |
| A6 | Tutorial is explained clearly with simple examples | 19 | 4 | 82.14 | 4 | 14.29 | 1 | 0 | 3.57 |
| A7 | Complete information related to learning outcomes is provided | 17 | 4 | 75.00 | 5 | 17.86 | 2 | 0 | 7.14 |
| A8 | Relevant and accurate information is given in the tutorial | 20 | 4 | 85.71 | 3 | 10.71 | 1 | 0 | 3.57 |
| A9 | Quizzes, practice questions and test are clearly explained | 18 | 5 | 82.14 | 4 | 14.29 | 1 | 0 | 3.57 |
| A10 | Learning style is helpful to understand the learning content | 19 | 5 | 85.71 | 2 | 7.14 | 2 | 0 | 7.14 |
| A11 | The tutorial is useful for self learning | 15 | 7 | 78.57 | 5 | 17.86 | 0 | 1 | 3.57 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| A12 | The tutorial provided me useful knowledge | 20 | 3 | 82.14 | 4 | 14.29 | 0 | 1 | 3.57 |
| A13 | Evaluation methods (quizzes and test) are useful to improve my academic performance | 17 | 8 | 89.29 | 2 | 7.14 | 0 | 1 | 3.57 |
| A14 | Grading structure for the test is appropriate | 15 | 5 | 71.43 | 5 | 17.86 | 2 | 1 | 10.71 |
| | **Platform quality** | | | | | | | | |
| B1 | KMSS is easy to use | 17 | 6 | 82.14 | 4 | 14.29 | 0 | 1 | 3.57 |
| B2 | I can find the required information easily | 16 | 6 | 78.57 | 4 | 14.29 | 1 | 1 | 7.14 |
| B3 | I have not encountered any system errors (e.g. for log in, e-mail, opening a new page, downloading a file, etc.) | 23 | 2 | 89.29 | 1 | 3.57 | 1 | 1 | 7.14 |
| B4 | Quick responses are provided by the system (e.g. for log in, e-mail, opening a new page, downloading a file, etc.) | 21 | 4 | 89.29 | 2 | 7.14 | 0 | 1 | 3.57 |
| B5 | Help in the system is useful | 18 | 4 | 78.57 | 5 | 17.86 | 0 | 1 | 3.57 |
| B6 | Graphical user interface of the KMSS is user friendly | 19 | 6 | 89.29 | 2 | 7.14 | 0 | 1 | 3.57 |
| B7 | The KMSS is easily accessible via Internet | 16 | 8 | 85.71 | 2 | 7.14 | 1 | 1 | 7.14 |
| B8 | The KMSS is accessible at any time during the session | 18 | 6 | 85.71 | 3 | 10.71 | 0 | 1 | 3.57 |
| B9 | Personalized pages in the KMSS are useful (e.g. scheduled activities, reminders, discussions, e-mails and messages etc.) | 18 | 5 | 82.14 | 4 | 14.29 | 0 | 1 | 3.57 |
| B10 | Learning from the KMSS is interactive (e.g. using video, audio, blogs, wikis and | 19 | 6 | 89.29 | 2 | 7.14 | 0 | 1 | 3.57 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | discussions etc.) | | | | | | | | |
| B11 | All the components of the system (e.g. links, files, audio and video etc.) are accessible | 18 | 6 | 85.71 | 3 | 10.71 | 0 | 1 | 3.57 |
| B12 | KMSS is a good educational platform and improves my learning | 19 | 4 | 82.14 | 4 | 14.29 | 0 | 1 | 3.57 |
| | **User satisfaction** | | | | | | | | |
| C1 | The KMSS is a very efficient and effective educational tool | 17 | 6 | 82.14 | 3 | 10.71 | 1 | 1 | 7.14 |
| C2 | The KMSS helped me to become more familiar with the module | 17 | 8 | 89.29 | 2 | 7.14 | 0 | 1 | 3.57 |
| C3 | The KMSS will improve my academic performance in the module | 18 | 6 | 85.71 | 3 | 10.71 | 0 | 1 | 3.57 |
| C4 | The KMSS makes the communication with fellow learners easier | 20 | 2 | 78.57 | 4 | 14.29 | 1 | 1 | 7.14 |
| C5 | The KMSS will help to manage my study time effectively | 15 | 8 | 82.14 | 3 | 10.71 | 1 | 1 | 7.14 |
| C6 | I am motivated to learn the module using the KMSS | 15 | 7 | 78.57 | 4 | 14.29 | 1 | 1 | 7.14 |
| C7 | I enjoy attending to the KMSS session overall | 16 | 8 | 85.71 | 3 | 10.71 | 0 | 1 | 3.57 |
| C8 | Overall, I am satisfied with the KMSS | 18 | 6 | 85.71 | 3 | 10.71 | 0 | 1 | 3.57 |

# Appendix 5.8: Summary of responses to questionnaire survey-from the University of Colombo, Sri Lanka

| | | Positive Responses | | | Neutral Responses | | Negative Responses | | |
|---|---|---|---|---|---|---|---|---|---|
| **Q. No.** | **Question** | **SA** | **A** | **% of SA and A** | **N** | **% of N** | **D** | **SD** | **% of D & SD** |
| | **Content quality** | | | | | | | | |
| A1 | The learning outcomes of the tutorial are stated clearly | 23 | 1 | 80.00 | 4 | 13.33 | 2 | 0 | 6.67 |
| A2 | The tutorial is easy to follow | 20 | 5 | 83.33 | 3 | 10 | 2 | 0 | 6.67 |
| A3 | The tutorial is interactive (e.g. learning using video, audio, animations and simulations etc.) | 19 | 4 | 76.67 | 5 | 16.67 | 1 | 1 | 6.67 |
| A4 | The tutorial content is up-to-date (e.g. content, examples, MySQL version, and references) | 19 | 5 | 80.00 | 4 | 13.33 | 2 | 0 | 6.67 |
| A5 | Consistent colours, images, tabs, words and phrases are used in the tutorial | 21 | 2 | 76.67 | 4 | 13.33 | 2 | 1 | 10.00 |
| A6 | Tutorial is explained clearly with simple examples | 19 | 3 | 73.33 | 7 | 23.33 | 1 | 0 | 3.33 |
| A7 | Complete information related to learning outcomes is provided | 18 | 7 | 83.33 | 3 | 10 | 2 | 0 | 6.67 |
| A8 | Relevant and accurate information is given in the tutorial | 13 | 13 | 86.67 | 3 | 10 | 1 | 0 | 3.33 |
| A9 | Quizzes, practice questions and test are clearly explained | 18 | 7 | 83.33 | 5 | 16.67 | 0 | 0 | 0.00 |
| A10 | Learning style is helpful to understand the learning content | 17 | 6 | 76.67 | 6 | 20 | 1 | 0 | 3.33 |
| A11 | The tutorial is useful for self learning | 17 | 9 | 86.67 | 3 | 10 | 1 | 0 | 3.33 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| A12 | The tutorial provided me useful knowledge | 17 | 6 | 76.67 | 6 | 20 | 1 | 0 | 3.33 |
| A13 | Evaluation methods (quizzes and test) are useful to improve my academic performance | 17 | 8 | 83.33 | 4 | 13.33 | 1 | 0 | 3.33 |
| A14 | Grading structure for the test is appropriate | 18 | 8 | 86.67 | 2 | 6.667 | 1 | 1 | 6.67 |
| | **Platform quality** | | | | | | | | |
| B1 | KMSS is easy to use | 20 | 6 | 86.67 | 3 | 10 | 1 | 0 | 3.33 |
| B2 | I can find the required information easily | 20 | 6 | 86.67 | 3 | 10 | 1 | 0 | 3.33 |
| B3 | I have not encountered any system errors (e.g. for log in, e-mail, opening a new page, downloading a file, etc.) | 20 | 5 | 83.33 | 4 | 13.33 | 1 | 0 | 3.33 |
| B4 | Quick responses are provided by the system (e.g. for log in, e-mail, opening a new page, downloading a file, etc.) | 17 | 6 | 76.67 | 7 | 23.33 | 0 | 0 | 0.00 |
| B5 | Help in the system is useful | 16 | 10 | 86.67 | 4 | 13.33 | 0 | 0 | 0.00 |
| B6 | Graphical user interface of the KMSS is user friendly | 16 | 7 | 76.67 | 6 | 20 | 1 | 0 | 3.33 |
| B7 | The KMSS is easily accessible via Internet | 19 | 6 | 83.33 | 4 | 13.33 | 1 | 0 | 3.33 |
| B8 | The KMSS is accessible at any time during the session | 17 | 8 | 83.33 | 5 | 16.67 | 0 | 0 | 0.00 |
| B9 | Personalized pages in the KMSS are useful (e.g. scheduled activities, reminders, discussions, e-mails and messages etc.) | 17 | 4 | 70.00 | 8 | 26.67 | 1 | 0 | 3.33 |
| B10 | Learning from the KMSS is | 14 | 11 | 83.33 | 4 | 13.33 | 1 | 0 | 3.33 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | interactive (e.g. using video, audio, blogs, wikis and discussions etc.) | | | | | | | | |
| B11 | All the components of the system (e.g. links, files, audio and video etc.) are accessible | 18 | 8 | 86.67 | 3 | 10 | 1 | 0 | 3.33 |
| B12 | KMSS is a good educational platform and improves my learning | 16 | 7 | 76.67 | 6 | 20 | 1 | 0 | 3.33 |
| | **User satisfaction** | | | | | | | | |
| C1 | The KMSS is a very efficient and effective educational tool | 15 | 8 | 76.67 | 7 | 23.33 | 0 | 0 | 0.00 |
| C2 | The KMSS helped me to become more familiar with the module | 16 | 8 | 80.00 | 5 | 16.67 | 1 | 0 | 3.33 |
| C3 | The KMSS will improve my academic performance in the module | 17 | 5 | 73.33 | 5 | 16.67 | 3 | 0 | 10.00 |
| C4 | The KMSS makes the communication with fellow learners easier | 20 | 5 | 83.33 | 4 | 13.33 | 1 | 0 | 3.33 |
| C5 | The KMSS will help to manage my study time effectively | 15 | 8 | 76.67 | 6 | 20 | 1 | 0 | 3.33 |
| C6 | I am motivated to learn the module using the KMSS | 18 | 8 | 86.67 | 3 | 10 | 1 | 0 | 3.33 |
| C7 | I enjoy attending to the KMSS session overall | 17 | 7 | 80.00 | 4 | 13.33 | 2 | 0 | 6.67 |
| C8 | Overall, I am satisfied with the KMSS | 23 | 2 | 83.33 | 4 | 13.33 | 1 | 0 | 3.33 |

SA: Strongly Agree, A: Agree, N: Neutral, D: Disagree, SD: Strongly Disagree

# Appendix 5.9: Comparison of the data collected from Keele University, UK and the University of Colombo, Sri Lanka

| | Positive Responses ( % of SA and A) | | | Neutral Responses (% of N) | | | Negative Responses (% of D & SD) | | |
|---|---|---|---|---|---|---|---|---|---|
| **Question number** | **UK (N=28)** | **SL (N=30)** | **Avg.** | **UK (N=28)** | **SL (N=30)** | **Avg.** | **UK (N=28)** | **SL (N=30)** | **Avg.** |
| **Content quality** | | | | | | | | | |
| A1 | 85.71 | 80.00 | 82.86 | 10.71 | 13.33 | 12.02 | 3.57 | 6.67 | 5.12 |
| A2 | 89.29 | 83.33 | 86.31 | 3.57 | 10.00 | 6.79 | 7.14 | 6.67 | 6.90 |
| A3 | 82.14 | 76.67 | 79.40 | 10.71 | 16.67 | 13.69 | 7.14 | 6.67 | 6.90 |
| A4 | 85.71 | 80.00 | 82.86 | 10.71 | 13.33 | 12.02 | 3.57 | 6.67 | 5.12 |
| A5 | 82.14 | 76.67 | 79.40 | 14.29 | 13.33 | 13.81 | 3.57 | 10.00 | 6.79 |
| A6 | 82.14 | 73.33 | 77.74 | 14.29 | 23.33 | 18.81 | 3.57 | 3.33 | 3.45 |
| A7 | 75.00 | 83.33 | 79.17 | 17.86 | 10.00 | 13.93 | 7.14 | 6.67 | 6.90 |
| A8 | 85.71 | 86.67 | 86.19 | 10.71 | 10.00 | 10.36 | 3.57 | 3.33 | 3.45 |
| A9 | 82.14 | 83.33 | 82.74 | 14.29 | 16.67 | 15.48 | 3.57 | 0.00 | 1.79 |
| A10 | 85.71 | 76.67 | 81.19 | 7.14 | 20.00 | 13.57 | 7.14 | 3.33 | 5.24 |
| A11 | 78.57 | 86.67 | 82.62 | 17.86 | 10.00 | 13.93 | 3.57 | 3.33 | 3.45 |
| A12 | 82.14 | 76.67 | 79.40 | 14.29 | 20.00 | 17.14 | 3.57 | 3.33 | 3.45 |
| A13 | 89.29 | 83.33 | 86.31 | 7.14 | 13.33 | 10.24 | 3.57 | 3.33 | 3.45 |
| A14 | 71.43 | 86.67 | 79.05 | 17.86 | 6.67 | 12.26 | 10.71 | 6.67 | 8.69 |
| **Platform quality** | | | | | | | | | |
| B1 | 82.14 | 86.67 | 84.40 | 14.29 | 10.00 | 12.14 | 3.57 | 3.33 | 3.45 |
| B2 | 78.57 | 86.67 | 82.62 | 14.29 | 10.00 | 12.14 | 7.14 | 3.33 | 5.24 |
| B3 | 89.29 | 83.33 | 86.31 | 3.57 | 13.33 | 8.45 | 7.14 | 3.33 | 5.24 |
| B4 | 89.29 | 76.67 | 82.98 | 7.14 | 23.33 | 15.24 | 3.57 | 0.00 | 1.79 |
| B5 | 78.57 | 86.67 | 82.62 | 17.86 | 13.33 | 15.60 | 3.57 | 0.00 | 1.79 |
| B6 | 89.29 | 76.67 | 82.98 | 7.14 | 20.00 | 13.57 | 3.57 | 3.33 | 3.45 |
| B7 | 85.71 | 83.33 | 84.52 | 7.14 | 13.33 | 10.24 | 7.14 | 3.33 | 5.24 |
| B8 | 85.71 | 83.33 | 84.52 | 10.71 | 16.67 | 13.69 | 3.57 | 0.00 | 1.79 |
| B9 | 82.14 | 70.00 | 76.07 | 14.29 | 26.67 | 20.48 | 3.57 | 3.33 | 3.45 |
| B10 | 89.29 | 83.33 | 86.31 | 7.14 | 13.33 | 10.24 | 3.57 | 3.33 | 3.45 |
| B11 | 85.71 | 86.67 | 86.19 | 10.71 | 10.00 | 10.36 | 3.57 | 3.33 | 3.45 |
| B12 | 82.14 | 76.67 | 79.40 | 14.29 | 20.00 | 17.14 | 3.57 | 3.33 | 3.45 |
| **User satisfaction** | | | | | | | | | |
| C1 | 82.14 | 76.67 | 79.40 | 10.71 | 23.33 | 17.02 | 7.14 | 0.00 | 3.57 |
| C2 | 89.29 | 80.00 | 84.64 | 7.14 | 16.67 | 11.90 | 3.57 | 3.33 | 3.45 |
| C3 | 85.71 | 73.33 | 79.52 | 10.71 | 16.67 | 13.69 | 3.57 | 10.00 | 6.79 |
| C4 | 78.57 | 83.33 | 80.95 | 14.29 | 13.33 | 13.81 | 7.14 | 3.33 | 5.24 |
| C5 | 82.14 | 76.67 | 79.40 | 10.71 | 20.00 | 15.36 | 7.14 | 3.33 | 5.24 |
| C6 | 78.57 | 86.67 | 82.62 | 14.29 | 10.00 | 12.14 | 7.14 | 3.33 | 5.24 |
| C7 | 85.71 | 80.00 | 82.86 | 10.71 | 13.33 | 12.02 | 3.57 | 6.67 | 5.12 |
| C8 | 85.71 | 83.33 | 84.52 | 10.71 | 13.33 | 12.02 | 3.57 | 3.33 | 3.45 |

SA: Strongly Agree, A: Agree, N: Neutral, D: Disagree, SD: Strongly Disagree

# Appendix 5.10: Average frequencies of the quality attributes from the questionnaire survey

| Quality attribute | Question numbers related to quality attributes and avg. frequency of positive response (%) (N=58) | Avg. Frequency (%) |
|---|---|---|
| **Content quality** | | |
| Content representation | A1 (82.86),A2 (86.31) | 84.58 |
| Consistency | A5(79.40) | 79.40 |
| Flexibility | A3 (79.40) | 79.40 |
| Interactive content | A3(79.40) | 79.40 |
| Learning model | A1(82.86),A3 (79.40), A6 (77.74), A9 (82.74) | 80.68 |
| Clarity | A6 (77.74) | 77.74 |
| Understandability | A2 (86.31) | 86.31 |
| Tutorial structure | A2 (86.31) | 86.31 |
| Up-to-datedness | A4 (82.86) | 82.86 |
| Learner assessment quality | A9 (82.74), A14 (79.05) | 80.89 |
| Well-organised | A1 (82.86), A2 (86.31), A5 (79.40) | 82.86 |
| Completeness | A7 (79.17) | 79.17 |
| Relevancy | A8 (86.19) | 86.19 |
| Accuracy | A8 (86.19) | 86.19 |
| Teaching and learning | A10 (81.19) | 81.19 |
| Reliability | A1 (82.86), A2 (86.31), A8 (86.19) | 85.12 |
| Information contextual quality | A1(82.86), A6 (77.74) | 80.30 |
| Self-regulated learning | A11 (82.62) | 82.62 |
| Usefulness | A12 (79.40) | 79.40 |
| Academic performance | A13 (86.31) | 86.31 |
| **Platform quality** | | |
| Easy to use | B1 (84.40), B2 (82.62), B5 (82.62), B6 (82.98) | 83.15 |
| Security | B3 (86.31) | 86.31 |
| Reliability | B3 (86.31) | 86.31 |
| Usability | B1 (84.40), B2 (82.62), B12 (79.40), C6 (82.62) | 82.26 |
| Help option available | B5 (82.62) | 82.62 |
| User friendly | B6 (82.98) | 82.98 |
| Well-organised | B1 (84.40), B2 (82.62) | 84.40 |
| Availability | B7(84.52) , B8 (84.52) | 84.52 |
| Personalisation | B9 (76.07) | 76.07 |

| | | |
|---|---|---|
| Interactivity | B10 (86.31) | 86.31 |
| Accessibility | B11 (86.19) | 86.19 |
| Response Time | B4 (82.98) | 82.98 |
| Easy to communicate | C4 (80.95) | 80.95 |
| **User satisfaction** | | |
| Efficiency and effectiveness | C1 (79.40) | 79.40 |
| Intention to use | C1 (79.40) | 79.40 |
| Learner attitudes towards KMSS | C1 (79.40) , C2 (84.64), C3 (79.52), C7 (82.86), C8 (84.52) | 82.19 |
| Enjoyable experience | C7 (82.86) | 82.86 |
| Learners' study habits (e.g. self learning) | A11(82.62) ,C5(79.40) , C6 (82.62) | 81.55 |
| Motivation/commitment/self esteem | C6 (82.62) | 82.62 |
| Communication with fellow learners | C4 (80.95) | 80.95 |
| Time management/time on task | C5 (79.40) | 79.40 |

# Appendix 5.11: Responses to open ended questions

| Your most preferred three features of KMSS | |
|---|---|
| 1 | Video Tutorial, Quiz |
| 2 | Explanations were detailed and descriptive |
| | It started from basics and developed into more complicated information |
| 3 | Layout, design, usability |
| 4 | Transcript |
| | Quiz |
| | Wiki |
| 5 | The Quiz |
| | Practical Exercises |
| | Explore your Knowledge |
| 6 | Video |
| | Transcripts |
| | Interface |
| 7 | The overall tutorial structure and the quizzes and the practical work well. |
| | 1) Information was clearly laid out |
| | 2) The tutorial effectively got across the basics required |
| | 3) The practical exercise was a useful way to cement knowledge |
| 8 | Examples provided |
| | Colour Scheme |
| | Speed of connection |
| 9 | Interface |
| 10 | Sound and Audio |
| | Accessible Tabs |
| | Good Interface |
| **Any other features that you like to have in KMSS** | |
| 1 | Video Chat |
| 2 | No |
| 3 | None, seems fairly extensive as it stands. |
| 4 | It seemed to be comprehensive |
| 5 | Response |
| 6 | Videos and more graphics will be really nice to improve the interaction |
| **Any other comments about your experience in using KMSS** | |
| 1 | The contrast of text over some images is a bit unclear |
| 2 | NA |
| 3 | It was a good learning experience to gain knowledge about MySQL using this software. |
| 4 | Some more explanation at times for some of the content could have been useful. (for example, the explanation of meta data) |
| 5 | I thought the KMSS was very simple to use and the graphics were smart and were useful. |
| 6 | N/A |
| 7 | None. |
| 8 | It’s wonderful software for learning online and at home. It makes learning fun |

# Appendix 6.1: Comparison of SLR and questionnaire survey results

| | Quality attribute | SLR | | Questionnaire survey | | Avg. Rank |
|---|---|---|---|---|---|---|
| | | % Frequency (N=12) | Rank | % Frequency (N=58) | Rank | |
| | **Content quality** | | | | | |
| 1 | Content representation | 50.00 | 3.00 | 84.58 | 11.00 | 7.00 |
| 2 | Consistency | 16.67 | 34.50 | 79.40 | 35.00 | 34.75 |
| 3 | flexibility | 16.67 | 34.50 | 79.40 | 35.00 | 34.75 |
| 4 | Interactivity | 16.67 | 34.50 | 79.40 | 35.00 | 34.75 |
| 5 | Learning model | 16.67 | 34.50 | 80.68 | 30.00 | 32.25 |
| 6 | Clarity | 16.67 | 34.50 | 77.74 | 40.00 | 37.25 |
| 7 | Understandability | 33.33 | 16.50 | 86.31 | 3.50 | 10.00 |
| 8 | Tutorial structure | 25.00 | 24.00 | 86.31 | 3.50 | 13.75 |
| 9 | Up-to-datedness | 41.67 | 8.50 | 82.86 | 18.00 | 13.25 |
| 10 | Learner assessment quality | 25.00 | 24.00 | 80.89 | 29.00 | 26.50 |
| 11 | Well-organised | 25.00 | 24.00 | 82.86 | 18.00 | 21.00 |
| 12 | Completeness | 41.67 | 8.50 | 79.17 | 39.00 | 23.75 |
| 13 | Relevancy | 41.67 | 8.50 | 86.19 | 8.00 | 8.25 |
| 14 | Accuracy | 41.67 | 8.50 | 86.19 | 8.00 | 8.25 |
| 15 | Teaching and learning | 41.67 | 8.50 | 81.19 | 26.00 | 17.25 |
| 16 | Reliability | 41.67 | 8.50 | 85.12 | 10.00 | 9.25 |
| 17 | Information contextual quality | 58.33 | 1.50 | 80.30 | 31.00 | 16.25 |
| 18 | Self-regulated learning | 33.33 | 16.50 | 82.62 | 21.00 | 18.75 |
| 19 | Usefulness | 41.67 | 8.50 | 79.40 | 35.00 | 21.75 |
| 20 | Academic performance | 25.00 | 24.00 | 86.31 | 3.50 | 13.75 |
| | **Platform quality** | | | | | |
| 21 | Easy to use | 58.33 | 1.50 | 83.15 | 14.00 | 7.75 |
| 22 | Security | 25.00 | 24.00 | 86.31 | 3.50 | 13.75 |
| 23 | Reliability | 33.33 | 16.50 | 86.31 | 3.50 | 10.00 |
| 24 | Usability | 16.67 | 34.50 | 82.26 | 23.00 | 28.75 |
| 25 | Help option available | 16.67 | 34.50 | 82.62 | 21.00 | 27.75 |
| 26 | User friendly | 16.67 | 34.50 | 82.98 | 15.50 | 25.00 |
| 27 | Well-organised | 16.67 | 34.50 | 84.40 | 13.00 | 23.75 |
| 28 | Availability | 41.67 | 8.50 | 84.52 | 12.00 | 10.25 |
| 29 | Personalisation | 16.67 | 34.50 | 76.07 | 41.00 | 37.75 |
| 30 | Interactivity | 8.33 | 41.00 | 86.31 | 3.50 | 22.25 |
| 31 | Accessibility | 33.33 | 16.50 | 86.19 | 8.00 | 12.25 |
| 32 | Response Time | 41.67 | 8.50 | 82.98 | 15.50 | 12.00 |
| 33 | Easy to communicate | 25.00 | 24.00 | 80.95 | 27.50 | 25.75 |
| | **User satisfaction** | | | | | |
| 34 | Efficiency and effectiveness | 41.67 | 8.50 | 79.40 | 35.00 | 21.75 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 35 | Intention to use | 33.33 | 16.50 | 79.40 | 35.00 | 25.75 |
| 36 | Learner attitudes toward KMSS | 16.67 | 34.50 | 82.19 | 24.00 | 29.25 |
| 37 | Enjoyable experience | 16.67 | 34.50 | 82.86 | 18.00 | 26.25 |
| 38 | Learners' study habits | 25.00 | 24.00 | 81.55 | 25.00 | 24.50 |
| 39 | Motivation/ commitment/ self esteem | 25.00 | 24.00 | 82.62 | 21.00 | 22.50 |
| 40 | Communication with fellow learners | 33.33 | 16.50 | 80.95 | 27.50 | 22.00 |
| 41 | Time management/ time on task | 25.00 | 24.00 | 79.40 | 35.00 | 29.50 |

# Appendix 7.1: Application of the quality assessment framework

**Frequency analysis of questionnaire survey for six KMS platforms**

| Question number | Average frequency (%) | | | | | |
|---|---|---|---|---|---|---|
| | KMSS | W3S | Keele Bb | Stanford | MIT | Open Uni. |
| **Content quality** | | | | | | |
| A1 | 87.50 | 62.50 | 50.00 | 62.50 | 50.00 | 37.50 |
| A2 | 100.00 | 62.50 | 37.50 | 62.50 | 62.50 | 62.50 |
| A3 | 75.00 | 62.50 | 50.00 | 62.50 | 50.00 | 37.50 |
| A4 | 100.00 | 87.50 | 50.00 | 75.00 | 50.00 | 62.50 |
| A5 | 100.00 | 75.00 | 50.00 | 62.50 | 37.50 | 62.50 |
| A6 | 100.00 | 87.50 | 50.00 | 75.00 | 75.00 | 62.50 |
| A7 | 100.00 | 62.50 | 62.50 | 62.50 | 50.00 | 50.00 |
| A8 | 100.00 | 62.50 | 87.50 | 75.00 | 75.00 | 50.00 |
| A9 | 100.00 | 50.00 | 62.50 | 50.00 | 62.50 | 50.00 |
| A10 | 87.50 | 75.00 | 75.00 | 62.50 | 50.00 | 50.00 |
| A11 | 100.00 | 62.50 | 62.50 | 62.50 | 62.50 | 62.50 |
| A12 | 87.50 | 75.00 | 62.50 | 62.50 | 75.00 | 50.00 |
| A13 | 87.50 | 62.50 | 62.50 | 62.50 | 25.00 | 50.00 |
| A14 | 75.00 | 50.00 | 62.50 | 37.50 | 62.50 | 37.50 |

| Question number | Average frequency (%) | | | | | |
|---|---|---|---|---|---|---|
| | KMSS | W3S | Keele Bb | Stanford | MIT | Open Uni. |
| **Platform quality** | | | | | | |
| B1 | 87.50 | 75.00 | 75.00 | 75.00 | 75.00 | 62.50 |
| B2 | 100.00 | 75.00 | 62.50 | 62.50 | 50.00 | 37.50 |
| B3 | 87.50 | 62.50 | 75.00 | 75.00 | 75.00 | 50.00 |
| B4 | 100.00 | 75.00 | 87.50 | 62.50 | 62.50 | 50.00 |
| B5 | 100.00 | 75.00 | 62.50 | 50.00 | 62.50 | 75.00 |
| B6 | 100.00 | 62.50 | 37.50 | 50.00 | 50.00 | 50.00 |
| B7 | 100.00 | 87.50 | 87.50 | 75.00 | 62.50 | 62.50 |
| B8 | 100.00 | 75.00 | 75.00 | 50.00 | 62.50 | 37.50 |
| B9 | 100.00 | 12.50 | 75.00 | 50.00 | 50.00 | 50.00 |
| B10 | 100.00 | 75.00 | 37.50 | 75.00 | 37.50 | 62.50 |
| B11 | 100.00 | 62.50 | 62.50 | 62.50 | 75.00 | 50.00 |
| B12 | 100.00 | 75.00 | 50.00 | 50.00 | 50.00 | 37.50 |

| Question number | Average frequency (%) | | | | | |
|---|---|---|---|---|---|---|
| | KMSS | W3S | Keele Bb | Stanford | MIT | Open Uni. |
| **User satisfaction** | | | | | | |
| C1 | 87.50 | 50.00 | 75.00 | 50.00 | 62.50 | 75.00 |
| C2 | 100.00 | 62.50 | 62.50 | 50.00 | 50.00 | 50.00 |
| C3 | 100.00 | 50.00 | 62.50 | 87.50 | 87.50 | 75.00 |
| C4 | 100.00 | 50.00 | 75.00 | 50.00 | 62.50 | 25.00 |
| C5 | 100.00 | 25.00 | 75.00 | 50.00 | 50.00 | 50.00 |
| C6 | 100.00 | 62.50 | 62.50 | 75.00 | 62.50 | 50.00 |
| C7 | 87.50 | 75.00 | 75.00 | 50.00 | 75.00 | 50.00 |
| C8 | 100.00 | 62.50 | 62.50 | 50.00 | 62.50 | 50.00 |

**Frequency of responses and rank for quality attributes for six KMS platforms**

**Content quality**

| Quality attribute | Question numbers | KMSS | | W3S | | Keele BlackBoard | | Stanford | | MIT | | Open Uni. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Average frequency (%) | Rank | Average frequency (%) | Rank | Average frequency (%) | Rank | Average frequency (%) | Rank | Average frequency (%) | Rank | Average frequency (%) | Rank |
| Content representation | A1, A2 | 93.75 | 30.00 | 62.50 | 26.00 | 43.75 | 37.00 | 62.50 | 21.00 | 56.25 | 28.00 | 50.00 | 26.00 |
| Consistency | A5 | 100.00 | 10.50 | 75.00 | 7.00 | 50.00 | 32.00 | 62.50 | 21.00 | 37.50 | 39.50 | 62.50 | 5.00 |
| Flexibility | A3 | 75.00 | 40.50 | 62.50 | 26.00 | 50.00 | 32.00 | 62.50 | 21.00 | 50.00 | 33.50 | 37.50 | 38.50 |
| Interactive content | A3 | 75.00 | 40.50 | 62.50 | 26.00 | 50.00 | 32.00 | 62.50 | 21.00 | 50.00 | 33.50 | 37.50 | 38.50 |
| Learning model | A1, A2, A5 | 95.83 | 24.00 | 66.67 | 15.50 | 45.83 | 35.50 | 62.50 | 21.00 | 50.00 | 33.50 | 54.17 | 13.50 |
| Clarity | A1, A6 | 93.75 | 30.00 | 75.00 | 7.00 | 50.00 | 32.00 | 68.75 | 8.50 | 62.50 | 16.00 | 50.00 | 26.00 |
| Understandability | A2 | 100.00 | 10.50 | 62.50 | 26.00 | 37.50 | 39.50 | 62.50 | 21.00 | 62.50 | 16.00 | 62.50 | 5.00 |
| Tutorial structure | A2 | 100.00 | 10.50 | 62.50 | 26.00 | 37.50 | 39.50 | 62.50 | 21.00 | 62.50 | 16.00 | 62.50 | 5.00 |
| Up-to-datedness | A4 | 100.00 | 10.50 | 87.50 | 1.00 | 50.00 | 32.00 | 75.00 | 4.00 | 50.00 | 33.50 | 62.50 | 5.00 |
| Learner assessment quality | A9, A14 | 87.50 | 36.00 | 50.00 | 37.00 | 62.50 | 21.50 | 43.75 | 41.00 | 62.50 | 16.00 | 43.75 | 37.00 |
| Well-organised | A1, A2, A5 | 95.83 | 24.00 | 66.67 | 15.50 | 45.83 | 35.50 | 62.50 | 21.00 | 50.00 | 33.50 | 54.17 | 13.50 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Completeness | A7 | 100.00 | 10.50 | 62.50 | 26.00 | 62.50 | 21.50 | 62.50 | 21.00 | 50.00 | 33.50 | 50.00 | 26.00 |
| Relevancy | A8 | 100.00 | 10.50 | 62.50 | 26.00 | 87.50 | 2.00 | 75.00 | 4.00 | 75.00 | 4.00 | 50.00 | 26.00 |
| Accuracy | A8 | 100.00 | 10.50 | 62.50 | 26.00 | 87.50 | 2.00 | 75.00 | 4.00 | 75.00 | 4.00 | 50.00 | 26.00 |
| Teaching and learning | A10 | 87.50 | 36.00 | 75.00 | 7.00 | 75.00 | 8.50 | 62.50 | 21.00 | 50.00 | 33.50 | 50.00 | 26.00 |
| Reliability | A1, A2,A8 | 93.98 | 27.50 | 65.74 | 17.00 | 56.13 | 28.00 | 64.58 | 11.50 | 57.29 | 26.50 | 51.50 | 16.00 |
| Information contextual quality | A1, A2, A6 | 93.98 | 27.50 | 67.06 | 14.00 | 54.16 | 29.00 | 64.58 | 11.50 | 57.29 | 26.50 | 52.16 | 15.00 |
| Self-regulated learning | A11 | 100.00 | 10.50 | 62.50 | 26.00 | 62.50 | 21.50 | 62.50 | 21.00 | 62.50 | 16.00 | 62.50 | 5.00 |
| Usefulness | A12 | 87.50 | 36.00 | 75.00 | 7.00 | 62.50 | 21.50 | 62.50 | 21.00 | 75.00 | 4.00 | 50.00 | 26.00 |
| Academic performance | A13 | 87.50 | 36.00 | 62.50 | 26.00 | 62.50 | 21.50 | 62.50 | 21.00 | 25.00 | 41.00 | 50.00 | 26.00 |
| Average | | 93.36 | 23.60 | 66.43 | 19.40 | 56.66 | 26.20 | 63.96 | 17.88 | 56.04 | 24.40 | 52.16 | 20.25 |

**Platform quality**

| Quality attribute | Question numbers | KMSS | | W3S | | Keele BlackBoard | | Stanford | | MIT | | Open Uni. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Average frequency (%) | Rank | Average frequency (%) | Rank | Average frequency (%) | Rank | Average frequency (%) | Rank | Average frequency (%) | Rank | Average frequency (%) | Rank |
| Easy to use | B1, B2, B5, B6 | 96.88 | 21.50 | 71.88 | 12.50 | 59.38 | 27.00 | 59.38 | 30.00 | 59.38 | 23.50 | 56.25 | 12.00 |
| Security | B3 | 87.50 | 36.00 | 62.50 | 26.00 | 75.00 | 8.50 | 75.00 | 4.00 | 75.00 | 4.00 | 50.00 | 26.00 |
| Reliability | B3 | 87.50 | 36.00 | 62.50 | 26.00 | 75.00 | 8.50 | 75.00 | 4.00 | 75.00 | 4.00 | 50.00 | 26.00 |
| Usability | B1, B2, B12, C6 | 96.88 | 21.50 | 71.88 | 12.50 | 62.50 | 21.50 | 65.63 | 10.00 | 59.38 | 23.50 | 46.88 | 36.00 |
| Help option available | B5 | 100.00 | 10.50 | 75.00 | 7.00 | 62.50 | 21.50 | 50.00 | 36.00 | 62.50 | 16.00 | 75.00 | 1.00 |
| User friendly | B6 | 100.00 | 10.50 | 62.50 | 26.00 | 37.50 | 39.50 | 50.00 | 36.00 | 50.00 | 33.50 | 50.00 | 26.00 |
| Well-organised | B1, B2 | 93.75 | 30.00 | 75.00 | 7.00 | 68.75 | 15.00 | 68.75 | 8.50 | 62.50 | 16.00 | 50.00 | 26.00 |
| Availability | B7, B8 | 100.00 | 10.50 | 81.25 | 2.00 | 81.25 | 4.00 | 62.50 | 21.00 | 62.50 | 16.00 | 50.00 | 26.00 |
| Personalisation | B9 | 100.00 | 10.50 | 12.50 | 41.00 | 75.00 | 8.50 | 50.00 | 36.00 | 50.00 | 33.50 | 50.00 | 26.00 |
| Interactivity | B10 | 100.00 | 10.50 | 75.00 | 7.00 | 37.50 | 39.50 | 75.00 | 4.00 | 37.50 | 39.50 | 62.50 | 5.00 |
| Accessibility | B11 | 100.00 | 10.50 | 62.50 | 26.00 | 62.50 | 21.50 | 62.50 | 21.00 | 75.00 | 4.00 | 50.00 | 26.00 |
| Response time | B4 | 100.00 | 10.50 | 75.00 | 7.00 | 87.50 | 2.00 | 62.50 | 21.00 | 62.50 | 16.00 | 50.00 | 26.00 |
| Easy to communicate | C4 | 100.00 | 10.50 | 50.00 | 37.00 | 75.00 | 8.50 | 50.00 | 36.00 | 62.50 | 16.00 | 25.00 | 40.50 |
| Average | | 97.12 | 17.62 | 64.42 | 18.23 | 66.11 | 17.35 | 62.02 | 20.58 | 61.06 | 18.88 | 51.20 | 23.27 |

**User Satisfaction**

| Quality attribute | Question numbers | KMSS | | W3S | | Keele BlackBoard | | Stanford | | MIT | | Open Uni. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Average frequency (%) | Rank | Average frequency (%) | Rank | Average frequency (%) | Rank | Average frequency (%) | Rank | Average frequency (%) | Rank | Average frequency (%) | Rank |
| Efficiency and effectiveness | C1, C5, C8 | 95.83 | 24.00 | 45.83 | 39.00 | 70.83 | 13.50 | 50.00 | 36.00 | 58.33 | 25.00 | 58.33 | 10.50 |
| Intention to use | C1, C7, C8 | 91.67 | 32.00 | 62.50 | 26.00 | 70.83 | 13.50 | 50.00 | 36.00 | 66.67 | 9.00 | 58.33 | 10.50 |
| Learner attitudes towards KMSS | C1, C2, C3, C7, C8 | 95.00 | 26.00 | 60.00 | 35.00 | 67.50 | 16.00 | 57.50 | 31.00 | 67.50 | 8.00 | 60.00 | 9.00 |
| Enjoyable experience | C7 | 87.50 | 36.00 | 75.00 | 7.00 | 75.00 | 8.50 | 50.00 | 36.00 | 75.00 | 4.00 | 50.00 | 26.00 |
| Learners' study habits (e.g. self learning) | A11 | 100.00 | 10.50 | 62.50 | 26.00 | 62.50 | 21.50 | 62.50 | 21.00 | 62.50 | 16.00 | 62.50 | 5.00 |
| Motivation/commitment/self esteem | C6 | 100.00 | 10.50 | 62.50 | 26.00 | 62.50 | 21.50 | 75.00 | 4.00 | 62.50 | 16.00 | 50.00 | 26.00 |
| Communication with fellow learners | C4 | 100.00 | 10.50 | 50.00 | 37.00 | 75.00 | 8.50 | 50.00 | 36.00 | 62.50 | 16.00 | 25.00 | 40.50 |
| Time management/time on task | C5 | 100.00 | 10.50 | 25.00 | 40.00 | 75.00 | 8.50 | 50.00 | 36.00 | 50.00 | 33.50 | 50.00 | 26.00 |
| Average | | 96.25 | 20.00 | 55.42 | 29.50 | 69.90 | 13.94 | 55.63 | 29.50 | 63.13 | 15.94 | 51.77 | 19.19 |

# Appendix 7.2: Questionnaire for the evaluation of the quality assessment framework for knowledge management software

**Questionnaire for evaluation of the quality assessment framework for knowledge management software**

***Instructions:*** Please tick on score for questions in sections A, and B.

Score: 1-Strongly Agree 2-Agree 3-Neutral 4-Disagree 5-Strongly Disagree

| **Section A: Understandability** | | | | | |
|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** |
| 1. Quality assessment framework for knowledge management software representation is very clear | | | | | |
| 2. It is easy to understand the definitions of quality attributes under three main categories of quality , e.g. content quality, platform quality and user satisfaction | | | | | |
| 3. Quality evaluation method using quality assessment framework for knowledge management software is easy to understand and unambiguous | | | | | |
| 4. No special knowledge or training on software evaluation is needed to use the quality assessment framework for knowledge management software | | | | | |
| 5. It is easy to use the quality assessment framework for knowledge management software | | | | | |

| **Section B: User Satisfaction** | | | | | |
|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** |
| 6. Quality assessment framework for knowledge management software can be applied to any knowledge management software to evaluate its quality | | | | | |
| 7. Using the quality assessment framework for knowledge management software, level of quality of knowledge management software can be evaluated | | | | | |
| 8. Quality assessment framework for knowledge management software can be used for making decision on selecting most appropriate knowledge management software based on its quality attributes | | | | | |
| 9. Quality assessment framework for knowledge management software is self-contained | | | | | |
| 10. The assessment method of the quality assessment framework for knowledge management software is useful | | | | | |
| 11. Quality assessment framework for knowledge management software is a useful tool for evaluating quality of knowledge management software | | | | | |
| 12. It is important to implement quality assessment framework for knowledge management software in the form of an automated software tool in order to facilitate evaluating quality of knowledge management software | | | | | |

| **Section C: Additional comments** |
| --- |
| 13. Are there any quality attributes that you may suggest to add to the framework?<br>1. --------------------------------<br>2. --------------------------------<br>3. -------------------------------- |
| 14. Please provide your comments relating to the assessment method used in this framework<br><br>-------------------------------------------------------------------------------------------------<br>-------------------------------------------------------------------------------------------------<br>-------------------------------------------------------------------------------------------------<br>--------------- |
| 15.Your suggestions to further improve quality assessment framework<br><br>-------------------------------------------------------------------------------------------------<br>-------------------------------------------------------------------------------------------------<br>-------------------------------------------------------------------------------------------------<br>--------------- |

Thank you for participating in this survey!

# Appendix 7.3: Information given for the evaluation of the quality assessment framework

# Information for evaluation of the quality assessment framework for knowledge management software

**Introduction**

The main contribution of this research is a quality assessment framework for knowledge management software. The quality assessment framework in this research was formalised based on the results of SLR and empirical study that has been carried out. A multi-element analysis technique, based on software engineering evaluation methods was adopted for the formalisation of the quality assessment framework. Overall quality of a KMS platform is presented as a single value using the framework described below.

The purpose of this document is to give an overview of the quality assessment framework for knowledge management software for evaluation of this framework. Please give your responses to the questionnaire given for the evaluation of this framework.

**Process of quality assessment framework design**

Figure 1 illustrates the stages involved in formalisation of the quality assessment framework. This process started with identifying research objectives. After reviewing the literature on research methods in software engineering, an empirical approach was adopted. Data collection was carried out using the Systematic Literature Review and a questionnaire survey. Data collection via questionnaire survey was followed by the evaluation of a KMSS prototype by regular users of knowledge management software. The results of data collected from these two methods were compared using frequency analysis. The quality assessment framework was formalised by combining three categories of quality attributes to represent the overall quality of a KMS platform using a single value. A multi-element analysis technique was adopted for the formalisation of the quality assessment framework.

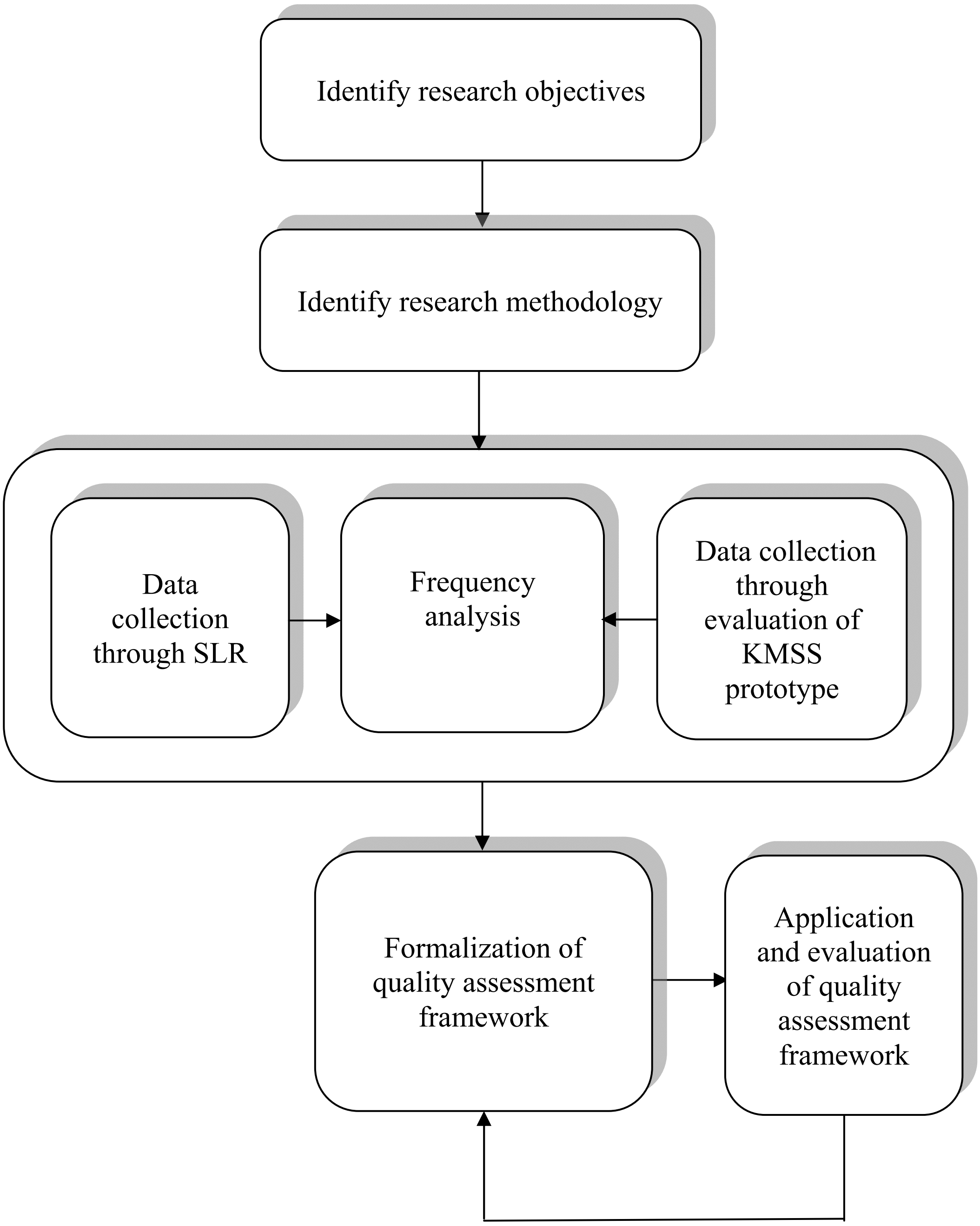



Figure 1 Stages in formalisation of the quality assessment framework

**Quality attributes in the quality assessment framework for knowledge management software**

Based on the analysis of results of data gathered through the SLR and questionnaire survey quality attributes of the quality assessment framework for knowledge management software were identified. This framework has three main categories of quality attributes: content quality, platform quality and user satisfaction. There are 41 quality attributes in this framework consisting of 20 attributes under content quality, 13 attributes under platform quality and 8 attributes under user satisfaction. The quality attributes in the quality assessment framework for knowledge management software is presented in Figure 2. A brief description of each quality attribute in this framework is given in Appendix 2.3 of the thesis.

| Content quality | Platform quality | User satisfaction |
|---|---|---|
| • Content representation | • Easy to use | • Efficiency and effectiveness |
| • Consistency | • Security | • Intention to use |
| • Flexibility | • Reliability | • Learner attitudes towards KMSS |
| • Interactive content | • Usability | • Enjoyable experience |
| • Learning model | • Help option available | • Learners' study habits |
| • Clarity | • User friendly | • Motivation/commitmen t/self esteem |
| • Understandability | • Well-organized | • Communication with fellow learners |
| • Tutorial structure | • Availability | • Time management/time on task |
| • Up-to-datedness | • Personalization | |
| • Learner assessment quality | • Interactivity | |
| • Well-organized | • Accessibility | |
| • Completeness | • Response time | |
| • Relevancy | • Easy to communicate | |
| • Accuracy | | |
| • Teaching and learning | | |
| • Reliability | | |
| • Information contextual quality | | |
| • Self-regulated learning | | |
| • Usefulness | | |
| • Academic performance | | |

Figure 2 Quality attributes of the quality assessment frameworks

**Quality assessment framework for knowledge management software**

This section describes the quality assessment framework formalised by combining three categories of quality attributes presented in Figure 2. In this framework overall quality of knowledge management software is represented as a single value using the quantitative evaluation method. A Quality Index is calculated based on the results of SLR and questionnaire survey as a single quantitative measure that represent the quality of knowledge management software.

In the proposed framework three main quality factors were identified and each factor consisted of a number of quality attributes (41 in total). A relative importance weight is assigned for each attribute inside the main category of quality attributes, and a relative importance weight for each category (i.e. content quality, platform quality and user satisfaction) in the overall Quality Index. The percentages of the weights of all attributes inside each category add up to 100%. In the same way, accumulated percentage weighting of the 3 categories of quality attributes would be always 100%. These identified factors for three categories of quality attributes and the associated metrics are mapped into a measurement scheme along with the relative importance weights for three categories and quality attributes under each category. Figure 3 shows the quality assessment framework and symbols used for each parameter used for calculation of overall quality score for knowledge management software.

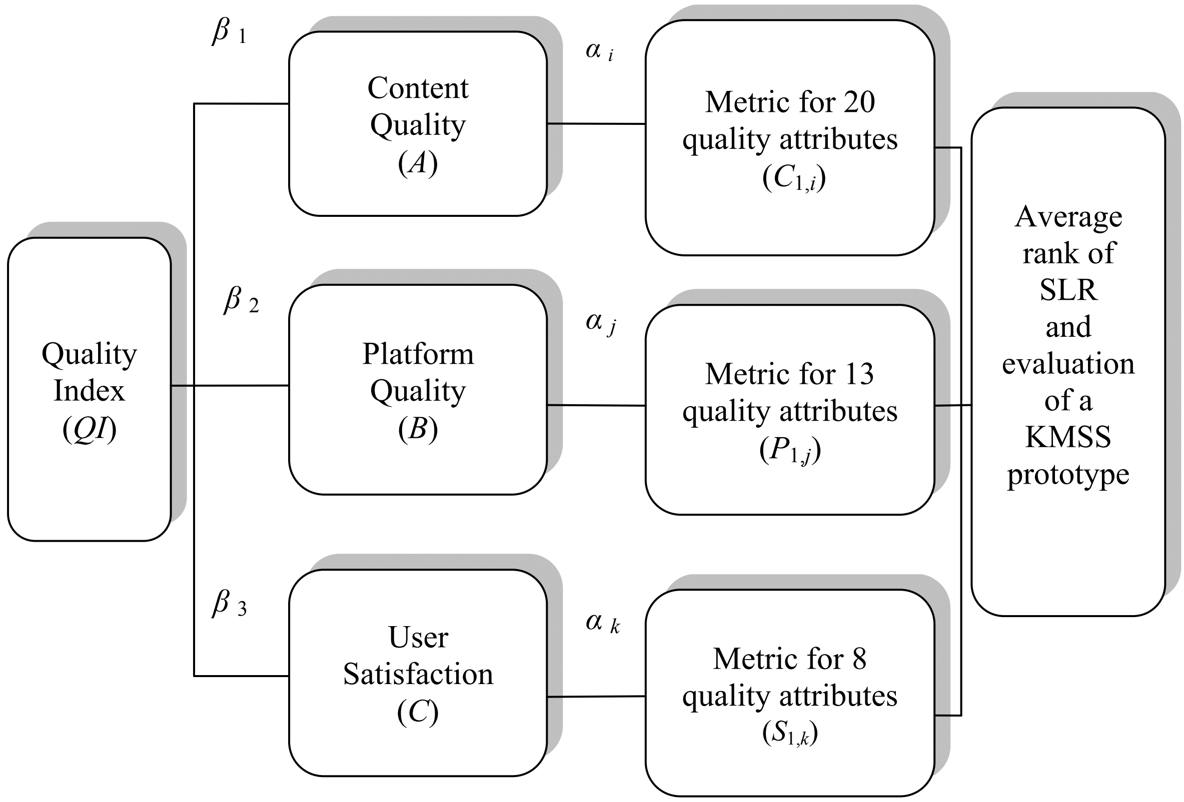



Figure 3 Quality assessment frameworks for knowledge management software

**Definitions of symbols used**

- $C_{1,i}$, $P_{1,j}$, and $S_{1,k}$: Metric calculated for each quality attribute under content quality ($i$=1 to 20), platform quality ($j$=1 to 13), and user satisfaction ($k$=1 to 8) respectively
- $\alpha_i$, $\alpha_j$ and $\alpha_k$: Weight assigned for each quality attribute under three categories of quality attributes ( i.e. content quality, platform quality and user satisfaction) respectively
- $A$, $B$ and $C$: Quality score calculated for three categories of quality attributes ( i.e. content quality, platform quality and user satisfaction) respectively
- $\beta_1$, $\beta_2$ and $\beta_3$: Weights assigned for each category of quality attribute ( i.e. content quality, platform quality and user satisfaction) respectively
- $QI$: Quality Index

**Method of calculation of the Quality Index ($QI$)**
This section explains the step by step process of calculation of the Quality Index.

**Step 1: Calculation of metric for each quality attribute ($C_{1,i}$, $P_{1,j}$ and $S_{1,k}$)**
Based on the data collected through SLR and questionnaire survey, average rank was calculated for each quality attribute.
$C_{1,i}$: Average rank of SLR and questionnaire survey for each content quality attribute where $i$=1 to 20
$P_{1,j}$: Average rank of SLR and questionnaire survey for each platform quality attribute where $j$=1 to 13
$S_{1,k}$: Average rank of SLR and questionnaire survey for each user satisfaction quality attribute where $k$=1 to 8

**Step 2: Calculation of weight for quality attributes ($\alpha_i$, $\alpha_j$ and $\alpha_k$ )**
Weights were assigned based on the relative importance of each attribute under each category of quality attribute (i.e. $\alpha_i$ is assigned for content quality attributes where $i$=1 to 20, $\alpha_j$ is assigned for platform quality attributes where $j$=1 to 13 and $\alpha_k$ is assigned for user satisfaction attributes where $k$=1 to 8)

**Step 3: Calculation of quality score for three categories of quality attributes ($A$, $B$ and $C$)**:
Quality score is the sum of average rank multiplied by weight for each quality attribute under content quality ($A$), platform quality ($B$) and user satisfaction ($C$).
Quality score for content quality ($A$) $=\sum \alpha_i (C_{1,i})$ where $i$ =1 to 20 (1)
Quality score for platform quality ($B$) $=\sum \alpha_j (P_{1,j})$ where $j$=1 to13 (2)
Quality score for user satisfaction ($C$) $=\sum \alpha_k (S_{1,k})$ where $k$=1 to 8 (3)

**Step 4: Calculation of weight for three categories of quality attributes ($\beta_1$, $\beta_2$ and $\beta_3$)**
$\beta_1$, $\beta_2$ and $\beta_3$ represent the relative importance of the three categories for the overall quality of KMSS. Average rank of content quality, platform quality and user satisfaction are ($w_1$) 20.13%, ($w_2$)19.77%, ($w_3$)25.19% respectively. Considering these average ranks, the relative importance weight of each category of quality attribute was calculated as illustrated below.
Weight for content quality ($\beta_1$)= $[w_1/(w_1+ w_2+ w_3)]$ 100 (4)

$$\beta_1= [20.13/(20.13+19.77+25.19)]100=30.92\%$$

Weight for platform quality ($\beta_2$)= $[w_2/ (w_1+ w_2+ w_3)]$ 100 (5)

$$\beta_2= [19.77/(20.13+19.77+25.19)]\ 100=30.38\%$$

Weight for user satisfaction ($\beta_3$)= $[w_3/(w_1+ w_2+ w_3)]$100 (6)

$$\beta_3= [25.19/(20.13+19.77+25.19)]\ 100=38.70\%$$

**Step 5: Calculation of quality factor for three categories of quality attributes ($QF_1$, $QF_2$ and $QF_3$)**

For each category of quality attribute a quality factor is calculated using the weights and the quality scores computed in the previous stages.

Quality factor for content quality ($QF_1$) = $\beta_1 A$ (7)
Quality factor for platform quality ($QF_2$) = $\beta_2 B$ (8)
Quality factor for user satisfaction ($QF_3$) = $\beta_3 C$ (9)

**Step 6: Calculation of Quality Index (*QI*)**

Considering the quality factor computed in the previous stage, and the total number of quality attributes in the quality assessment framework, overall Quality Index is calculated. The value of overall Quality Index is considered for making decision on the quality of a selected KMS platform.

*QI*= (Sum of Quality Factor for content quality, platform quality and user satisfaction/number of quality attributes) 100

$$QI=[(QF_1+QF_2+QF_3/\ n)]100=[(\beta_1 A + \beta_2 B + \beta_3 C)/n]100 \qquad (10)$$

Where $n=i+j+k$

Calculation of overall Quality Index using each step described above is used for comparative evaluation of KMS platforms.

# Appendix 8.1: Publications used in the mapping study for RQ1 (supplementary literature review)

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# Appendix 9.1: Dissemination activities undertaken throughout the research

1. “A Quality Assessment Framework for Knowledge Management Software” (Unpublished Journal article)
2. “Systematic Literature Review: A Quality Assessment Framework for Knowledge Management Systems” (Unpublished Journal article)
3. ”Data Collection for Formalization of Quality Assessment Framework for Knowledge Management Software”, Seminar presentation, 20th September 2013, School of Computing and Mathematics, Keele University, UK
4. “Evaluation of Quality Assessment Framework for Knowledge Management Software” for Post Graduate Research Symposium 09th April 2014, School of Computing and Mathematics, Keele University, UK
5. “A Quality Assessment Framework for Knowledge Management Software”, Poster Presentation a for the 6th York Doctoral Symposium on Computer Science (YDS 2013),29th October,2013, University of York, UK
6. ”Reflections on Conducting Systematic Literature Review: A Quality Assessment Framework for KMSS”, Proceedings of Knowledge and Information Management (KIM 2013) conference 4th-5th June 2013, Coventry, UK
7. Presentation on ”Reflections on Conducting Systematic Literature Review: A Quality Assessment Framework for KMSS” Knowledge and Information Management (KIM 2013) conference 4th-5th June 2013, Coventry, UK
8. ”Mapping Study: A Quality Assessment Framework for KMSS”, Proceedings of Knowledge and Information Management (KIM 2013) conference 4th-5th June 2013, Coventry, UK
9. Presentation on ”Mapping Study: A Quality Assessment Framework for KMSS” for Knowledge and Information Management (KIM 2013) conference 4th-5th June 2013, Coventry, UK
10. ”Conducting a Systematic Litereture Review”, Invited Speech, Post Graduate Research Showcase 2013, University of Colombo, 30th January 2013, Sri Lanka
11. “Lessons Learned on Conducting Systematic Literature Review” for Post Graduate Research Symposium 16th January 2013, School of Computing and Mathematics, Keele University, UK
12. “Towards a Quality Assessment Framework for KMSS: A Mapping Study” for Post Graduate Research Symposium 30th June 2011, School of Computing and Mathematics, Keele University, UK
13. Systematic Literature Review Protocol: A Quality Assessment Framework for a Knowledge Management Software, Seminar Presentation, School of Computing and Mathematics, Keele University, UK, May 2011