Open Source E-Learning Application Adoption: Medical Colleges in a Developing World

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PhD Abstract

A review of normative literature, in the field of Electronic Learning (e-learning) implementation, indicates that traditional approaches to e-learning implementation in higher education have failed to result in cost effective, integrated and sustainable learning environment. In addressing this issue, a new movement called Open Source (OS) has emerged and addresses most of traditional e-learning application by resulting in the development of reusable and manageable platforms. The use of Open Source E-Learning Applications (OSELA) in Higher Education Institutes (HEI) is a new research area with many research issues needing to be investigated. At this end, OSELA adoption has not efficiently studied with HEI and researchers needing to understand and analyze OSELA adoption.

This work examines the introduction of Open Source E-Learning Applications in Higher Education Institutes and proposes a novel model for its adoption. The model is based on a comprehensive set of factors that influence the introduction of OSELA in HEI.

The work is based on a qualitative case study approach to examine the concepts of the proposed model for the adoption of OSELA. In doing so, three case studies were conducted in Medical Higher Education Institutions. The case studies were presented and analyzed. However, some modifications were made to the conceptual model as some complementary factors emerged during the empirical research. The main factors that influence the adoption of OSELA are**:** (a) costs; (b) benefits; (c) barriers; (d) external pressures; (e) support; (f) level of IT sophistication; (g) limitations of existing IT infrastructure, (h) internal pressure and, (i) an evaluation framework that supports higher education institutes to assess OSELA.

The proposed model makes novel contribution and can be used as a decision-making tool to support management when taking decisions regarding the adoption of OSELA. Additionally, it can be used by researchers to analyse and understand the adoption of Open Source Software for E-learning.

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To my brothers and sisters, who were supportive with their prayers for me in this journey, I say thank you for your patience, continuous support and encouragement and thank you for being there when I most needed you.

Say, "O my Lord! Advance me in knowledge."

To Samro and Fatuma,

Shahira,

Atef Naga, and

My beloved family

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Chapter 1

Introduction

Chapter 1. INTRODUCTION

During the last decade, the continuous and rapid advancement and development in Information and Communication Technology (ICT) have led Higher Education Institutes (HEI) to dramatically change learning methodologies, create new learning environments and adopt various Information Systems (IS) to automate their learning processes. Moreover, the Internet has radically changed the way professors and students can access information. The concept aimed at utilising ICT tools and the Internet to improve the learning processes and its availability and accessibility is referred to as Electronic Learning or simply (e-learning).

Public HEI in developing countries are facing scarce financial resources, lack of technical skills, poor IT infrastructure, and large numbers of students versus small numbers of academic staff. Although e-learning comes with promises for HEI such as lowering expenses and maximizing revenues, overcoming educational challenges, and solving administrative problems; the challenges and costs associated with proprietary software form barriers that make e-learning implementation and deployment hardly possible.

In recent years, emerging software called Open Source Software (OSS) has attempted to effectively address many proprietary software problems and thus, result in the development of free, flexible, and maintainable information systems. OSS is a new research area and therefore, scientific research and literature around it, remain limited. Moreover, the impact of OSS on HEI remains under explored especially in developing countries.

In addressing this issue, the research presented in this thesis investigates and evaluates the *impact of adopting open source software on e-learning implementation in public higher education institutes in developing countries as well as its adoption*. This chapter explains why existing proprietary software has limitations in providing e-learning solutions to higher education institutes, introduces OSS as an alternative method to implement e-learning, and discusses the need for the development of a single integrated Open Source E-Learning Application (OSELA). The aim and objectives of this research are defined with an outline of the dissertation presented at the end of this chapter.

1.1 Background to the Research Problem: E-learning evolution in higher education and the need for innovative solutions

The definition of e-learning varies from simply "the online delivery of information for purposes of education, training, or knowledge management" (Garrison and Anderson 2003, Allen and Seaman 2003), to "all activities relevant to instructing, teaching and learning using various types of electronic media" (Olla, 2007). A more comprehensive definition is given by the European Union as it states: "E-learning encompasses new applications and services based on information and communication technologies (ICT), designed to help individuals, organisations and society as a whole to enhance skills through better, more continuous learning processes" (European Commission Information Society 2005). (Ma *et al.* 2009) define e-learning as "An ideal learning environment using modern means of Information Technology (IT), through the effective

integration of IT and the curriculum to achieve a new learning style which can fully reflect the main role of the education to train large members of high quality personnel".

In higher education, e-learning is emerging and becoming increasingly prominent, with universities increasing provision and more students engaging. There is a great hope that e-learning will solve many problems, improve professional development, encourage collaboration, and integrate technology into curricula (Broadbent 2002). In the literature, many authors like (Baltes 2010, Dhanarajan 2001) claim that the implementation of e-learning tools will raise the number of students who have access to higher education. In the UNESCO teacher report, there are strong beliefs that e-learning will have huge potential for government to meet a growing demand for education while facing an escalating shortage of teachers (Mason 2006).

In the normative literature, many researchers identified the benefits of e-learning, such as time reduction, large volume and diversity of learners, cost reduction, higher content retention, flexibility, updated and consistent material, and the creation of a fear free learning environment (Zhang *et al.*, 2004); (Liaw *et al.* 2007, Delahoussaye *et al.* 2001, Urdan and Weggen 2000).

Despite the numerous potential benefits, (Turban, *et al.* 2010) cite some drawbacks like:

- the need of instructor retraining,
- equipment needs and support services,
- maintenance and updating,
- protection of intellectual property,
- Computer literacy and student retention.

In developing countries, e-learning has recently been extensively studied, and much researches surrounding its benefits, barriers and challenges has been conducted (Al-Senaidi, Lin and Poirot 2009, Al-Khalifa 2009, Hashim 2008, Ali and Magalhaes 2008,

Wan *et al.* 2008, Sife *et al.*, 2007). Still, there are many other challenges other than educational technology to be considered, such as the lack of e-learning components in certain areas for example, computers, internet accessibility and proper bandwidth (Heeks 2002, Rajesh 2003), the lack of skills, shortage of online teachers and lack of active participative students (Evans 2005, Sehrt 2004). In their recent study, Andersson and Grönlund (2009) found 30 specific challenges for e-learning in both developed and developing countries. Those 30 challenges were grouped into four categories, namely: courses, individuals, technology and context.

While technology plays a major part in any e-learning initiatives, still the decision to use this technology is crucial in a way that is aligned with institution's merits and values (Olla, 2007) and with different learning styles (Collins, 2009), and the technology chosen should support the chosen learning model and pedagogy (Dewever, 2006). In today's global changes in education environment, leaders must be innovative to not only elevate the stature of their institutions, but simply to survive. The demands on higher education require both a fundamental change in direction, and the technology to facilitate that change.

1.2 Proprietary Software in Higher Education

Higher Education is idiosyncratic and has many business practices that are unique and essential to the sector. The size and structure of higher education as an industry is not conducive to sustaining a robustly competitive market (Wheeler, 2007), it is small relative to other large sectors of the economy. This yield the higher education domain software to be dominated by a few major vendors which most HEI rely on to support their virtual learning environment and learning management systems that deliver online learning components. In the past several years HEI have adopted many e-learning applications, most of which were commercial applications or "Proprietary Software". The term Proprietary Software describes software developed by a business enterprise to generate profit from the licensing and rental or sale of the software itself. The term "Closed Source" is to indicate that the source code is to be treated as confidential and proprietary information belongs to the developer alone (Bartlett, 2004).

While some HEI have been well served by proprietary Software, others have been disappointed. In their research Courant and Griffiths (2006) found dissatisfaction among sixty-six stakeholders across higher education with the cost, performance, and control of proprietary software. Some interviewees expressed concerns that large vended systems gave institutions too little flexibility to adapt systems for specific needs. They were charged for adaptation and were required to pay high fees for local customisations to meet their academic needs. Indeed, proprietary software does not always allow modification of the code, nor access to application databases, making it difficult to customise or localise the application for a particular campus environment without incurring extra cost. From a technical perspective, this vendor lock "Closed Source" makes it difficult to integrate the proprietary system with other campus technologies such as student information systems and financial systems (Brooks, 2007). These scenarios left HEI locked in to software that is expensive to upgrade and to maintain.

Moreover, studies reported the decline of the number of commercial Learning Management Systems (LMS) over the past ten years from a dozen to just a few, causing many HEI to become concerned about the risk of monopolisation in the commercial LMS marketplace (Collins, 2009, Lakhan and Jhunjhunwala 2008). The changing proprietary software vendor business models and increasing mergers and acquisitions, created fear, uncertainty, and doubt about the future of proprietary software in the higher education sector (van Rooij 2009).

1.3 The need for an Integrated Open Source E-Learning Application (OSELA)

During the past years, much of the research conceived e-learning as a single product that is Learning Management System (LMS), though there is considerable heterogeneity amongst the teaching and learning, research, administrative, library, infrastructure and HEI needs at institutions and their respective communities. The market is offering a large open source application variety that covers different HEI administrative, technical, and academic needs (Dewever 2006). The OSS learning applications (including LMS)

differ in the type of solution they provide and none of these applications alone combine all features to fulfill HEI requirements (Sclater 2008).

Today's students and staff have high expectations for the IT services that colleges and universities should provide. They assess colleges and universities' IT services with other public services free offerings (unlimited storage for e-mail, videos and files; social networking, accessibility to personalised contents, etc.). Technology expectations of students who were born in the digital age, and a long list of staff requirements for e-learning functionality are beyond the capability of any LMS (Smith *et al.* 2009, Palfrey and Gasser 2008). These challenging expectations are forcing HEI to improve efficiencies and enhance performance whilst adopting new technologies to remain competitive. HEI are looking for a comprehensive, fully functional system which is built for higher education, to fit its unique business processes and interactively linking the different layers and functions of governance (Wilsdon and Bentley 2003). Expectations are growing for updated and effective systems that are more usable for end users, more flexible for administrative, regulatory, and policy changes and that provide the necessary functionality required by higher education. Van Rooij (2009) clarified HEI need to have an integrated learning environment that serves both academic and administrative needs, and create a balance between sound pedagogy and business efficiency.

In the Higher Education domain, there has been and increasing requirement for institutions to provide flexible opportunities for study, enabling learners to combine college, work-based and home-based learning (Laurillard 2005). This flexibility is extremely important for learners who need to see the relevance of their education through application. But this flexible accessibility to the system requires seamless coordination between all applications across the institution, and a very different way of thinking about the relationship between knowledge, skills and their application. One of the major obstacles for such ambitions was the cost. Wherever flexibility was provided, more integration and interoperation between applications were needed, and an automatic increase in cost occurred.

It is becoming clear that in order to fulfill HEI requirements and meet students and staff expectations, there is a need to piece together different available open source e-learning programmes into one single integrated Open Source E-Learning Application (OSELA) that can coordinate resources, sustain software, and enable campus-wide interoperability. By the use of OSELA, the cost of integration could be significantly reduced, as most of the possible selected applications are using the same software architecture and share the same coding platform. Gozdiskowski and Chen (2007) considers open source as a great solution for any university looking to start an integrated virtual university. They claim that with open source, HEI can start immediately with a base and develop from it to incorporate more applications.

1.4 OSELA

Following on from discussions in the previous sections, HEI need a unified e-learning system that integrates all e-learning applications. The present and next paragraphs introduce the main research area of this dissertation, which is Open Source E-Learning Application (OSELA) adoption and evaluation.

Whilst OSS innovation has been extensively studied with several studies of OSS adoption in public organisations (Rentocchini and Tartari 2010, Lundell *et al.* 2006, Rossi *et al.* 2006, Ven *et al.* 2007), there is very little research literature on the adoption of Open Source Learning Management System (OSLMS) in higher education institutes (Machado 2005, van Rooij 2009, van Rooij 2007, Albarrak *et al.* 2010, Khelifi *et al.* 2009). According to the author's best knowledge, there is no study that addressed the adoption of campus wide integrated e-learning applications either through OSS or Proprietary Software. This is primarily due to the reason that the introduction of technology in education was gradual and over many years. The early adopters did not have all available technology and scope to plan for integrated e-learning platform. Every new technology was pieced together with the legacy system and evolved in a more robust system. Another reason is due to the novelty of the OS phenomenon in the higher education e-learning domain.

According to Source Forge, a large open source public repository, the number of registered open source projects specifically intended for the education sector is 5,235 projects and applications (SourceForge 2010). Adding other large open source public repositories like FreshMeat, and EduForge , the number of projects and application is over 7,000. Those educational projects focus on a variety of solutions, such as portals, classroom testing and assessment, library systems, learning management systems, content development and authoring tools amongst other applications.

As the Open Source E-learning market offering is very heterogeneous with a large product variety, there is a confusion surrounding the use of open source applications and tools in higher education institutes. For this diversity OS e-learning applications exist, and there is an increasing need to know how to evaluate them in order to choose the best applications that can interoperate together and share a common, managed set of features that will satisfy and accommodate the ever changing needs of HEI. In the same context, the variation of HEI needs, and increased system complexity, trigger the need for an evaluation framework to assist decision makers in their selection process.

The OSS term in this thesis will refer to all software that is produced and developed following the model of Open Source as defined by the OSI. It will include all applications developed either for general use, specific industrial purpose, education domain or any other domain. Meanwhile, the term OSLMS will be used to identify the Open Source Learning Management System that is used solely for teaching and learning purposes and is developed for e-learning activities (E.g. Moodle, Sakai, Kuali, etc.). While the term OSELA is introduced by the author and will be used to determine the integrated platform that integrates all applications related to the creation of e-learning environment and campus wide e-learning applications.

On the other hand, the terms Free Open Source Software (FOSS) and Free/Libre Open Source Software (FLOSS) are also used for describing the Open Source in the literature. While all terms describe the same category of software (accessibility to use and modify

the code) but say different things about the software values and represents different philosophies in the open source movement.

1.5 Research Aim and Objectives

1.5.1 Research Aim

Much of the research surrounding OSS has focused inward on the phenomenon itself, studying the motivations of developers and community members to contribute to OSS projects, or investigating the characteristics of specific OSS products and projects. Far less has been done in looking outward at the process of OSS adoption, and to the author's knowledge to date; only a few studies have focused on the adoption of OSS for e-learning in HEI. Furthermore, to the best of the author's knowledge, OSELA adoption and evaluation is the first study into adoption of integrated open source e-learning applications in public HEI.

Therefore, to better understand the issues surrounding OSELA, HEI may benefit from a frame of reference to support the building of an integrated learning environment. Such a frame of reference will better help HEI to understand the impact of OSELA on both academic and administrative structures, before proceeding with their investment strategy. In doing so, HEI may maximise business benefits, gain strategic advantages, and transform the institution. As a result, the aim of this thesis is to:

Evaluate the adoption of Open Source E-Learning Application (OSELA) inn Higher Education Institutes in developing countries.

1.5.2 Research Objectives

- To conduct a comprehensive literature review in the area of e-learning in Higher Education with a particular focus on Open Source Software adoption and evaluation.
- To identify barriers, benefits and costs associated with the adoption of OSS in higher education.

- To assess approaches associated with the adoption of OSELA. In doing so, identifying why, how and in what way OSELA has been adopted.
- To develop and propose a frame of reference that can be translated into a model for OSELA adoption and evaluation.

1.5.3 Thesis Outline

The structure of this PhD thesis follows the methodology described by (Phillips and Pugh 2005) and consists of four elements namely: (a) background theory; (b) focal theory; (c) data theory and (d) novel contribution. Background theory focuses on assessing the field of research and identifying the problem domain (Chapters 2 and 3). The second element of the dissertation (focal theory) deals with generating conceptual models. This is explained and discussed in Chapter 4. Data theory addresses issues such as: (a) the most appropriate epistemological stance to adopt; (b) the development of a suitable research methodology and, (c) the conditions affecting the choice of research strategy. These issues are discussed in Chapter 5 of this thesis. In addition, data theory deals with the data collection process and analysis, which is reported in Chapter 6. The fourth element (novel contribution) is concerned with aligning the importance of the thesis, to the development of the discipline being researched which is reported in Chapter 7. The conclusions and future reaserchs are summarised in Chapter 8. The dissertation is composed of eight chapters with each of the chapters providing an understanding to various issues viewed to be critical for this research. The dissertation outline is explained in the following paragraphs.

Chapter 1: Introduction

Chapter 1 begins by providing an introduction to the main issues that the research will address. These issues focus on the need to adopt and implement e-learning systems and applications in Higher Education Institutes in a more flexible and maintainable way. Thereafter, the aim and objectives of the research are stated. The chapter ends with the dissertation outline.

Chapter 2: Egypt Higher Education System

Chapter two explores the Higher Education System in Egypt. By discussing the nature of Egyptian HE system, the author attempts to clarify the challenges of the current situations and the opportunities e-learning will bring to the sector reform.

Chapter 3: Literature Review – Background Theory

Having provided a brief introduction to the area of research and establish the scope, the dissertation then begins to review the literature on Open source. It begins with describing the limitations of proprietary software in higher education; explore the opportunities, benefits and barriers to open source adoption in HEI with more focus on developing countries.

Chapter 4: Open Source E-Learning Application Adoption Model - Focal Theory

Chapter 4 attempts to review the diversity of open source e-learning applications and proposes a novel taxonomy for categorising Open source e-leaning applications types. Thereafter, Chapter 4 investigates the nature of different OSELA and proposes a novel evaluation framework to evaluate them. The evaluation framework contributes towards a better understanding of the capabilities of each application. Thereafter, a novel model for the adoption of Open Sourced E-Learning Applications (OSELA) is developed and analysed. The model proposes factors that influence the adoption of OSELA namely: (a) costs; (b) benefits; (c) barriers; (d) external pressures; (e) support; (f) level of IT sophistication; (g) limitations of existing IT infrastructure and, (h) an evaluation framework that supports higher education institutes to assess (OSELA). Chapter 4 ends by discussing opportunities and challenges for developing countries to use OSELA.

Chapter 5: Research Methodology – Data Theory

Chapters 3 and 4 are setting the background of this research and help the author to understand and identify research issues. To undertake the research that focuses on these issues, a research methodology has to be followed. The reasoning behind the

research methods is stated within Chapter 5. The inherent problems within the various research philosophies are stated and the suitability to this research is provided. The research strategies existing within the IS field are also described and discussed within this chapter.

Chapter 6: Case Studies and Preliminary Research Findings - Data Theory

Having obtained an understanding of all the relevant issues for this research, the dissertation then provides a description of the case studies studied for this research. In this context, three Higher education medical colleges in a developing country are studied and their attempts to implement OSELA are reported. Chapter 6 provides a background to the colleges and describes and analyses the main issues including: (a) the motivations to OSELA adoption; (b) the adoption process; (c) the evaluation of OSELA; (d) the pilot case studies and (e) OSELA benefits, barriers and costs.

Chapter 7: OSELA Adoption Model – Novel Contribution

Based on the case studies and the research findings, the conceptual model proposed in Chapter 4 is revised. The revision implies adding and removing some factors.

Chapter 8: Conclusions and future research

In drawing the discussion to a close, Chapter 8 summarises the research presented in this dissertation. The novel contribution is also identified in this chapter. Additionally, it provides the major conclusions reached regarding the possible limitations of the research and describes and discusses potential areas of further research.

Chapter 2

Literature review

Chapter 2. LITERATURE REVIEW

This chapter presents a critical review of e-learning literature with focus on Open Source Software adoption in higher education sector. The chapter starts by investigating the general applicability of OSS in higher education in general, and goes on to focus on issues relevant to developing countries in specific. The aim of this chapter is to provide the background knowledge needed to identify and analyse factors and why they influence the adoption of OSS by HEI. Moreover, the review of previous studies in this field allows for the identification of lessons that can help in better understanding the adoption of OSS by HEI in this study. In doing so, this chapter presents: (a) Key factors in adopting OSS in higher education (b) classification for OSS benefits and barriers, and (c) factors related to OSS adoption in HEI in developing countries.

Section 2.1 starts with defining open source software, then section 2.2 starts reviewing the background of the research problem and exploring the limitation of proprietary software used for e-learning implementations in HEI. Then section 2.3 begins to explain the motivations to adopt OSS in HEI. This identifies a set of factors relevant to the adoption of OSS. Sections 2.4 and 2.5 discuss the benefits, and barriers associated with

the adoption of OSS in HEI and classify them. Sections 2.6 and 2.7 discuss issues related to the opportunities and challenges for the adoption of OSS by HEI in developing countries.

2.1 Open Source

Open source software (OSS) has elicited a great deal of research interest across a range of disciplines since the term was introduced in late 1990s. The underlying concept of open source software is access to statement and codes written by developers of a certain programme in a programmeming language such as Java, Php, and C++. This accessibility allows the user to use and modify the code as needed.

The term free software was first proposed and adopted by Richard M. Stallman, the father of the free software movement (Stallman, 2010). To accomplish his cherished goal of free software sharing, Stallman decided to devise an open operating system, the source code of which can be accessed, used, and modified freely by any one. Stallman called the result free software and named it GNU Project. Along with the GNU Project, Stallman also established the Free Software Foundation (FSF) to further promote the concept of free software and announced four types of freedom:

1. Run a software programme for any purpose,
2. Study how the programme works, and adapt it to an individual's or organisation's needs,
3. Redistribute copies to help other developers, and
4. Improve the programme and release those improvements to the whole community.

Access to the source code is the basis for the above four types of freedom. Consequently, Free Software Foundation defines free software definition as follows: Free software is a matter of the users' freedom to run, copy, distribute, study, change and improve the software. Users should be free to redistribute copies, either with or

without modifications, either gratis or charging a fee for distribution, to anyone anywhere. Publishing changes should not be required to notify anyone in particular, or in any particular way. The freedom to redistribute copies must include binary or executable forms of the program, as well as source code, for both modified and unmodified versions.

As mentioned above, free software does not refer to software that is distributed at no charge, but the term was found to be misleading and hindered the commercialization of free software. Therefore, an alternative term was sought. Finally the term open source software was chosen, its characteristics defined, and the *Open Source Initiative* (OSI) which is an organisation dedicated to managing the open source campaign and its certification mark, has expanded beyond the freedom to use software and specified what is permissible in a software licence for that software to be referred to as open source (Open Source Initiative 2009), including:

1. Free redistribution;
2. Source code access;
3. Distribution of modification works;
4. Integrity of author's source code;
5. No discrimination against persons or groups;
6. Distribution of Licence;
7. Licence not specific to a product;
8. Licence non-restrictive of other software, and
9. Licence is technology neutral.

Consequently, Open Source Institute defines open source software by the specific terms. Open source software do not just mean access to code, the distribution terms of open-source software must comply with the free redistribution, the source code, free right for modifications and derived works, integrating the author's source code. License must not discriminate against any person or specific field. Program must apply without the need for execution of an additional license, license must not be specific to a product or restrict other software and license must be technology-neutral.

The FSF and the OSI represents two distinct philosophies in the open source movement. FSF considers that proprietary software limits the users' right of sharing is immoral. Therefore, FSF is against private software patents and other restrictions. However, open source software's core idea is that open source software represents a more efficient development model than proprietary software. OSI thought perhaps in the end the open source culture will triumph not because cooperation is morally right or proprietary software is morally wrong, but simply because the closed source world cannot win the race with open source communities can put orders of magnitude more skilled time into a problem. From Stallman's view, open source is a development methodology; free software is a social movement. The FSF continues to use the term "Free Software", to express the idea that freedom, not just technology, is important. While the OSI continues to use the term "Open Source", to refer to the concept and practice of making programme source code openly available. "Free Software" and "Open Source" describe the same category of software, more or less, but say different things about the software, and about values. Common to both the FSF and OSI is the belief in access to source code.

However, there is a dangerous ambiguity in the term "Free Software" in the FSF definition, due to "free" meaning both "freedom" and "gratis". Free Software does not have to be gratis, even more it usually is not, or at least, not completely. Moreover, the FSF believes it to be immoral and unethical to use anything other than free software, whereas the OSI believes that there is a place for both open and closed-source software.

In this thesis, in order to eliminate the confusion surrounding the term (Free) and to conform with OSI beliefs of open and closed-source systems coexistence, the term "Open Source Software (OSS)" will be the term used when referring to programmes and software with code openness availability (accessibility to use and modify the code) and users' freedom of use and redistribution of software. Therefore, it is the OSI's concept of open source that is used throughout this thesis.

Fitzgerald (2006) explored OSS main characteristics and values. Freedom to use, share, modify and redistribute is one of a set of principles and values explored by Fitzgerald

that ensure the integrity of OSS. Users of OSS have access to the source code, and are free to modify it to suit their specific requirements. In the same context, the open source model promotes collaboration and sharing of resources. It creates a community of people that work together to achieve common goals and OSS users can rely on the Open Source Community or a third party vendor for technical support. Finally, OSS is mostly free; users do not have to pay upfront fees to purchase the software nor do they have to pay for annual licence, fees for upgraded versions, or updates.

In the literature, many arguments are favouring OSS when compared to proprietary software. Olla (2007) and Lakhan and Jhunjhunwala (2008) noted that benefits using OSS, amongst many others, are increased quality, greater stability, reduced vendor reliance, reusability, service community, and reduced cost and reliability. Voightmann and Coleman (2003) included OSS as an example of technology for the common good. Moreover, van Rooij (2009) considers it a means of eliminating vendor Licence fees and identified five benefits dominating the literature surrounding OSS, namely; (a) Social and philosophical benefits; (b) software development methodology benefits; (c) security and risk management benefits; (d) software adoption life cycle benefits; and (d) total cost of ownership benefits.

Open source advocates point to an extensive body of research in the field of information systems that explores the benefits and risks of open source in the context of (a) social movement theory and appeals to the common good (Coleman, 2004; Franck & Jungwirth, 2003; Kelty, 2004; O'Mahoney, 2002; Perens, 1999), (b) a new paradigm in software development methodology, where developers participate without monetary compensation (Evans, 2002; Raymond, 2001; Scacchi, 2001; Stewart & Gosain, 2004; Von Krogh, 2003), and (c) security and risk management (Raymond, 2001; Stallman, 1999; Weber, 2004). Other conceptual frameworks in the literature include the Diffusion of Innovations theory first developed by Rogers (1995), applied to the adoption of technology by Moore (1991, 2005), then applied to the adoption of open source software, with technical skills as a critical barrier to adoption (Evans, 2002). Organizational know-how and ability to respond to innovation has also been the basis for framing open source adoption (Au & Kaufmann, 2003)

2.2 LIMITATION OF PROPRIETARY SOFTWARE IN HIGHER EDUCATION

In their comprehensive report, Courant and Griffiths (2006) noted that the use of proprietary software in e-learning implementation in higher education sector in the past few years has resulted in many drawbacks including among others the need for extra cost to prepare IT infrastructure for special hardware requirements. Pfaffman (2007) claimed Proprietary software to be inconvenient when used in the higher education sector. It is inconvenient to purchase additional Licences for new machines, to negotiate a new Licence agreement each year, to support multiple versions of a package for machines purchased at different times, and it is inconvenient for students not to have the same software at home and at university. Moreover, in their study, Machado (2005) claims that the most popular reasons HEI respondents gave for choosing OSS packages over proprietary software was interoperability. Interoperability and open standards are fundamental prerequisites for a holistic and integrated IT environment which ensure the reusability of many of the objects that are free copyrighted. In the same context, the eLearning Industry Group (e-Learning Industry Group 2009) fully supports the openness of the learning process and the interoperability of learning related services and digital educational resources. Moreover, it calls for the Internet-scale platforms used for educational and learning purposes to be open standards based and should allow open integration with complementary services. This limitation of proprietary software is reflected in various areas. These areas are represented in the following sub sections.

2.2.1 Financial

Public higher education institutes are under pressure of annual budgets decreasing and increasing performance accountability. Tight budgets have focused attention on software acquisition costs and total cost of ownership, resulting in growing resentment of vendor power, particularly in the wake of price increases and licensing changes which many institutions felt powerless to reject (Coppola and Neelley 2004). Meanwhile, Stunden (2003) noted that cuts in higher education budgets and the flurry of proprietary software vendor mergers and acquisitions increased HEI fears of future monopolisation. This is supported by the domination of administrative and learning management systems by a small number of companies, which limited the range of options available.

2.2.2 Technical

E-learning projects tend to integrate various services into one integrated platform to support different institutional needs and requirements. The closed model offered by the proprietary software causes many obstacles for institutions that need to unify their information systems and fully automate their operations. The situation becomes more complicated when future needs to add different applications or services to the platform as in the majority of cases in higher education.

2.2.3 Managerial

Many studies have noted that the adaptation from industry proved to be of little use in higher education sector and often does not fit or comply with educational institutions (Courant and Griffiths 2006). Furthermore, proprietary software was shoehorned into academic environment and resulted in less functionality, expensive customisation, and locking institutions into single source contracts (Brooks 2007). Meanwhile, HEI administrators started questioning the ability of proprietary software vendors to provide the higher education sector with specific products in academic areas in a stable and affordable manner (Abel 2006).

2.2.4 Pedagogical

In many reported case studies, academic staff were not happy with the performance and results of some systems after being purchased and deployed. This could be justified as in the majority of cases, decision making related to the selection of LMS was done by administration (biased to financial and managerial issues) and not by academics (biased to pedagogical and learning features). The only solution for some systems was to move from one provider to another, which is costly since expensive customisations and localisation had to be repeated and interfaces with other systems had to be rebuilt.

2.3 Motivation of OSS adoption in HEI

Nowadays, Higher Education Institutes (especially the public ones) are under pressure to provide quality education and use of technology to enhance learning activities. At the

same time, there is rising pressure on colleges and universities to contain the cost of higher education and to leave more money in the treasury for academic pursuits, rather than for overhead expenditure (Machado and Thompson 2005, Dewever, 2006). Colleges' tight resources will be unable to keep pace with the rapidly growing demand for IT services or meet students and staff high expectations (Wheeler, 2007) nor can they afford to pay for a proprietary application that can be locked and will not be able to interoperate with future needed applications (Brooks, 2007). On the contrary, colleges and universities need applications and systems capable of continuously reconfiguring themselves to create new sources of public value. These contradictions, and the combined effect of financial and technological pressure, have encouraged many HEI to look towards creative, and alternative ways, as well as innovative approaches of using scarce resources to support inducing technology to learning, teaching and research (Bayne, 2009).

Today's higher education environment is marked by heightened accountability and decreased budgets. In such an environment, no higher education institution can afford to ignore alternative approaches that could result in more effective and less costly solutions (Trappler 2009). Many studies have noticed an increase in the adoption of OSS in e-learning. In their study among more than 450 further and higher education institutions in the U.K., Cox and Emmott (2007) noticed a dominance of OSS in LMSs adoption with Moodle adoption of (39%) followed by Blackboard (19%) and WebCT (9%). These adoption trends increased noticeably in 2008 (Canas 2009). Similar study in the U.S.A found a dramatic increase in awareness and in OSS LMSs adoption in the past few years (van Rooij 2011). In order to understand the reasons that led HEI to adopt OSS in their e-learning projects, this section summarises the main motivations to OSS adoption in HEI.

OSS adoption studies involving public sector enterprises found cost savings to be a major factor in adoption decisions (Fitzgerald and Kenny 2003, Waring and Maddocks 2005, Ven *et al.* 2007). Considerable interest has also been shown in OSS by the education sector. While the zero acquisition cost of OSS makes it an attractive alternative to proprietary software, many studies considered additional factors. Glance

et al. (2004) noted the increasing interest in OSS by HEI due to the promise of: a reduced total cost of ownership of the software, potentially better support, freedom from vendor lock–in, ability to tailor the software and pedagogic benefits of being able to view the source code, which is most useful when having staff who understand it. Charpentier and Carbone (2004) stated in their report that the need for greater flexibility, more competition in software supplies, and, finally, direct cost savings will tend to justify considering OSS in the next decade. Miralles *et al.* (2005) included factors like technological attributes, network externalities, organisational capabilities, vendor lock-in, influence of the user community, and low total cost when making OSS adoption decisions.

Recently, a study conducted by Ven *et al.* (2008) identified five distinct adoption factors for OSS as: (1) Cost advantages, (2) Source code, (3) Maturity, (4) Vendor lock-in, and (5) External support. A similar study conducted by the Alliance for Higher Education Competitiveness proposed total cost of ownership, integration with campus infrastructure, better functionality and security to be the strengths of open source software in higher education context (Abel, 2006). Factors such as much lower cost, being more customised, easier Licence management, being community driven and community serving were affecting the decision of HEI to adopt OSS (Gozdiskowski and Chen, 2007). Coppola and Neelley (2004) documented some of the most compelling drivers for use of Open Source Software in education to be: (1) tight budgets that focused attention on software acquisition costs, (2) Growing resentment of vendor power, and (3) Lack of innovation. Brooks noted that the value proposition for open source applications has derived HEI to favour OSS on proprietary applications (Brooks, 2007). The value proposition for open source applications can be summarised as a combination of cost (total cost of ownership), control (freedom to use the code) and the possibility of innovation (the community source).

Classification for the value proposition for open source application to proprietary software is summarised in table (2.1).

Classification	Sub Classification	References
Cost	cost savings, reduced total cost of ownership, low total cost, lower cost, cost advantages	Brooks, 2007 Gozdiskowski, 2007 Ven *et al.* 2007 Ven *et al.* 2008 Abel, 2006 Miralles *et al.* 2005 Waring and Maddocks, 2005 Glance *et al.* 2004 Charpentier and Carbone, 2004 Fitzgerald and Kenny, 2003
Community	better support, influence of the user community, community driven, community serving, external support	Gozdiskowski, 2007 Miralles *et al.* 2005 Glance *et al.* 2004 Ven et *et al.* 2008
Freedom	Freedom from vendor lock in, ability to tailor software, integration, greater flexibility, functionality, security, customisation, Licence management	Gozdiskowski, 2007 Abel, 2006 Glance *et al.* 2004 Ven *et al.* 2008

Table 2.1: Classification for the value proposition for open source application to proprietary software

2.3.1 Cost

Most of the literature on open source adoption has identified the cost as the most important metric for making adoption decisions (van Rooij, 2011). It could be argued that the current economic climate has pushed the cost of ownership to be of top priority for many organisations (Chapman, 2001). As there are no Licence fees for open source applications (i.e fees for the intellectual property of the software), there are strong assumptions that OSS implementation and deployment is less expensive to use than proprietary software. However, to the author best knowledge, there is little systematic research or studies to support this assumption. In addition, many institutions interpret the term "free" to mean the software is gratis. Stallman (2010) emphasises that "free" in free software does not mean without a price or with no cost, but means the freedom to use, share, modify, and redistribute the software. He also emphasised that there should be a cost associated with the deployment and implementation of the software.

Many studies have shown that organisations tend to appreciate the fact that OSS is free of charge (Ven and Mannaert, 2008) whilst other studies showed that the term free is misleading, and that OSS might not be much less expensive than proprietary software due to reasons such as switching costs (costs necessary to migrate data from the old system to the new one and the costs required to retrain personnel) (Goode 2005, Morgan and Finnegan 2007) and the Total Cost of Ownership (TCO) (Lundell 2006, Larsen *et al.*, 2004). A recent study showed that the cost saved by not paying a proprietary software Licence by adopting OSS is spent on the salaries and benefits of people who maintain and support the OSS, i.e. there are some spending which will happen internally (Wang *et al.* 2010). Therefore, HEI adopting OSS need to calculate all the costs associated with the implementation and deployment of OSS in their local context resulting in better analysis for the TCO of software in order to provide a valuable insight into adoption decisions.

Calculating the TCO of software is a complex, multifaceted issue and must be computed over the lifetime of the project. It requires consideration of many factors, including software purchase, maintenance and upgrade costs, labour costs, personnel training, and legal and administrative costs (David and Shapiro 2007, Russo, *et al.* 2005). According to Weber (2003), the TCO for OSS and proprietary software analysis has been controversial, in part because the cost details of upgrades, maintenance and support of OSS is rather ambiguous relative to proprietary pricing. Moore (2009) amongst others oversees the usage of open source application in higher education, which could be more expensive than proprietary software.

The justification for this being that managing open source application (i.e. installation, support, maintenance) and adjusting it to fit a particular institutional culture (i.e. customisation, Localisation and integration with existing systems) can be as labour intensive and expensive as buying proprietary software. The culture differences could have an impact on the TCO of OSS. The cost of support and maintenance could be amplified in an environment with less talented labour, insufficient IT support or in the context of a society with minimum knowledge concerning open source technologies. In

that case, the deployment could be risky, and the high demand on scarce support resources could increase the cost of OSS implementation.

Therefore, Ven and Verelst (2008) suggest that the result of one TCO cannot be generalised in other environments. That is why TCO comparison studies should be performed in the environment in which the adoption will occur. Yet, in some stages of ownership, OSS may be advantageous to the TCO. For instance, OSS can be downloaded and tested instantly without making any payment making the OSS acquisition gratis. Deployment, support and training are sometimes more expensive with OSS, in this context, Alterman (2004) claims that open source is a marketing strategy by which vendors make money from selling support and other services to institutions adopting open source software. In contrast, several proprietary software companies have put a great deal of effort into making their software simple to install and configure.

Nevertheless, the accessibility to the source code allows the use of internal expertise to repair errors or modify customisation, as well as to enlist external support from the open-source community worldwide. Given this complexity, proprietary and open source advocates predictably have each claimed a lower TCO (Wheeler, 2010). The following section highlights the differences between open source and proprietary software deployment costs.

Proprietary software measures costs upfront for licensing, and annually for maintenance, support, annual Licence and upgrade fees. Additionally, costs for integration, interoperation, customisation and localisation are all due as they occur. On the contrary, as for open source software, the upfront cost is avoided as there are no Licence fees. Annual maintenance and support are decoupled from the software product and they can be provided either by the use of staff time or can be purchased from a third party. Similarly, cost for integration, interoperation, customisation and localisation are minimised. Additionally, available solutions for customisation and localisation might be shared by other institutions (Brooks 2007, Abel 2006, Katz 2006).

Table (2.2) summarises the deployment cost differences between Proprietary and Open Source Software:

Cost Items	Proprietary Software	Open Source Software
Initial Licence	Upfront payment	Not available
Annual Licence	Over time	Not available
Maintenance	Annual purchased	Either staff time or purchased from 3rd party
Upgrade	Purchased when occur	No additional fees
Support	Annual purchased	Staff time, Purchased from 3rd party, community
Integration & Interoperation	Either embedded into Licence cost or purchased	Easily modified by staff, purchased from 3rd party, shared from other institutes
Customisation & Localisation	Purchased Separately	Easily modified by staff, purchased from 3rd party, shared from other institutes
Re-customisation	Additional cost	No additional cost

Table 2.2: Deployment cost differences between Proprietary and Open Source Software

However, when comparing proprietary software to OSS by eliminating upfront Licence fees, HEI will have less money to invest at the beginning, which means that the use and test of an application could start directly after its installation on the campus servers. This gives the institute an added option of installing the software prior to taking the decision of implementing it, which enables the full testing of the functionality, gives a lead time to the institution to test its popularity, usage, and perceived benefits among the students and staff before planning for further investments in support, maintenance and customisation. This option is mostly not available with proprietary software, where at most only limited versions, in terms of functionality or time, are given freely for trying out the software (Van den Berg, 2005).

On the other hand, eliminating annual subscription, updates and upgrade costs will direct all available budgets for implementation to other areas such as the support, training and maintenance. Using open source software, institutions will benefit from the decoupling of software from the support (Wheeler, 2007). This separation which unlocks the support to the software vendor only gives HEI better options to choose from, which could be: (a) recruit permanent talented staff, (b) rent third party support services, and (c) buy commercial open source packages that come with support from the vendor. Moreover, large institutes can establish a unit with talented staff and outsource the support to other institutions, thus making a profit from introducing the open source e-learning applications.

According to Wichmann (2004), half of the most important criteria for deciding in favour of OSS applications are related to cost saving. Although the importance of cost as an influencing factor in the adoption of OSS, different articles and research papers had contradictory claims regarding it being the advantage or disadvantage of OSS adoption. The previous sections showed different claims on OSS cost varying from zero cost claims up to being more expensive than the proprietary software.

Furthermore, table (2.2) showed an analysis for the payments needed in different categories of software deployment and compared with OSS and proprietary software. While these studies inform us of the influence of cost on the adoption of OSS, in the current literature there is a dearth of studies and reports to investigate the TCO of adopting OSS and comparing it to the adoption of proprietary software. There is a paucity of research on how much is spent after an open source product or service has been adopted. The body of knowledge is sparse in this crucial area, more studies are needed to report cases and implementation processes for adopting OSS and the TCO associated with it.

The author claims that the deployment of OSS will certainly be accompanied by a certain cost. This cost is proportional of the size of the deployment (how many applications, level of interoperability between application, amount of customisation and

localisation, number of users, size and number of campus, etc.) and the availability of the talented human support (staff for installation, maintaining, and support). Furthermore, the payment due will be distributed depending on the phases of deployment, which will give the adopting organisation more control over its spending. In the same context, the OSS will have an economical impact on the adopting society, especially in case of developing countries. The cycle of spending will be initiated and terminated inside the society. This will have a major impact on decreasing unemployment rates, increasing the number of businesses, decreasing the dependence on foreign currencies to pay Licence to "usually" foreign software companies, and strengthening the local economy.

2.3.2 Community

One of the reported drivers for open source adoption in education is the availability of the support community. Sclater (2008) said that one of the most valuable benefits an institution can have when deciding to select open source application is full engagement with the community behind that product. Several studies have suggested that the availability of a support community is an important factor that influences the decision to adopt OSS and that the absence of external support may be an important barrier to the adoption of OSS (Li *et al.* 2005 Morgan and Finnegan 2007, Goode 2005, West and Dedrick 2006, Ven and Mannaert 2008). The community of an Open Source application is a very important factor throughout the application life cycle. It is the community that does most of the testing and provides quality feedback. Instead of using financial resources to put the software through extensive testing and Quality Assurance (QA), like a proprietary vendor will do, the Open Source projects have the community as a resource.

Wheeler (2007) emphasises the role of open discussion communities that involves end-users, developers, and support staff. These communities lead to quick moves through several design alternatives and reaches a decision as the software is still being written. This is supported by Brooks (2007) who stated that the open source development provides the shortest distance between a software user and a software developer giving the developers more clarity regarding requirements as to what users actually need. The

more people are interested in a project, the more likely it is that it will be active and keep going. A large and active community says something about the acceptance of the software. If the software was not good enough to use, there would not be so many people who cared about its development (Duijnhouwer and Widdows 2003).

Moreover, the community provides external support to end-users after implementation decreasing the total cost of ownership for the application on the institution. However, these communities greatest appeal is the leveraging of resources of the partners and the community for shared value creation. One solution to an HE problem could involve many partners to help solve. Once the solution is valid and tested, all HEI can use it. The community source model for developing and sustaining software is a remarkable fit to the culture and core values of higher education (i.e. discovery, knowledge sharing, and scholarly communities) (Coppola and Neelley, 2004). Such leverage and collaboration is motivating institutional contributions by colleges, universities and commercial firms to provide tools for software to be created for educators by educators. This value added option never applicable in proprietary applications.

Lambert (2005) warned that higher education still needs to work with the vendor community to minimise risk. Wheeler (2007) also emphasised the importance of 3rd party service providers. These service providers offer support and training to institution seeking OSS adoption but may not have staff with the necessary knowledge or capability. The influence of technical support in OSS adoption is further confirmed by the fact that it, along with software quality, significantly impacts the satisfaction of individual OSS users. In contrast, van Rooij (2007) claims that these professional services organisations are mostly technical and are providing their services directly to the technical users, and there is still a need for supporting services available for academic and business applications. Similarly, Wang *et al.*, (2010) emphasised that it is critical to have communities where their members are from the same industry.

The author supports the argument of van Rooij (2007) that most of the available communities surrounding OSS used in higher education for e-learning are technical

communities focusing on the code, development, and programming. Despite considerable recent evidence available in the literature that OSS LMSs have sustainable committees that provide support as well as technical expertise (Collins 2009, McDonald 2009), the academic staff needs OSS LMS to be easy to use, essential, and evident, so that they know how to use it (Haymes, 2008). There is little knowledge on communities that provide training and support for the learning functionality of the software (i.e. how can academics use this software to achieve learning goals and outcomes). Most of the e-learning open source applications are written by technologists, academics need to have communities which get the best out of the software and support its functional usage (i.e. the what's in it for me (WIFM) is clear).

2.3.3 Freedom

The Free Software Foundation (FSF) enumerates four basic freedoms it deems necessary for the distinction of OSS the freedom to use software any way one wishes, the freedom to modify it to do whatever one wants it to, the freedom to pass it on to others, and the freedom to distribute modifications to others (Stallman, 2010). However, the author argues that this definition though available for both individuals and organisations, is more individual oriented. Hereby, the author draws on the FSF definition for the freedom of "free" OSS in the author's classification for the major distinctive factors for OSS adoption in HEI. Based on Stallman's definition, he used the term freedom to combine the three terms widely available in the literature. Freedom from vendor (avoiding vendor lock-in) freedom to use the code (to modify and to develop new software), and freedom to use the support (decoupling the vendor from the support)

2.3.3.1 Reducing Vendor lock-in

One of the reasons for OSS adopting for organisations is to become less dependent on their software vendors (West and Dedrick 2006, Larsen *et al.* 2004). Dissatisfaction of the majority of the institutions was found for the increase in prices, payment for update, customisation etc. (Courant and Griffiths 2006, Pfaffman 2007). It is still always possible to move from one vendor to another, but this will entail a significant switch in

cost in the proprietary software model. On the contrary, in Open source models, where OSS supports for open standards facilitate the development of compatible products which then eliminate the dependency of a single vendor. Even when organisations decide to move from one vendor to another, the cost is significantly less, as there will be no lost cost for Licence of the old system or new costs for the new Licences (costs may still be incurred for moving data, and retraining personnel) (Ven and Verelst, 2008).

2.3.3.2 Source Code

The source code availability is one of the advantages of the OSS movement. However, the literature is controversial in this area. Lakhan and Jhunjhunwala (2008) claim that although OSS offers open code, typical users are not interested in the availability of source code; they are more concerned with the software's usability. This is consistent with early studies in this field (Dedrick and West 2004, Larsen *et al.* 2004, Fitzgerald and Kenny 2003) questioned the importance of code availability if no one uses it. In contrast Coppola and Neelley (2004) emphasis that open source Licence corrects the balance of power between producers and consumers of software and gives control and freedom to the users. Courant and Griffiths (2006) also claim that open-source development provides the shortest distance between a software user and a software developer leading to a more rapid and diverse innovation.

Similarly, more than half (58%) of the 257 higher education CFOs participating in a survey sponsored by National Association of College and University Business Officers in the United States (NACUBO) stated that the freedom to modify software source code was the primary reason for their interest in adopting open-source software applications (Hignite, 2004). Institutions can develop additional functionality at their own pace, select a service provider based on its respective merits rather than waiting for a proprietary vendor to include a feature, and wait for another development cycle. In the same context, many believe that OSS will provide both academics and technologists affording them flexibility to maintain the balance between technology and pedagogy (Morgan and Finnegan 2007, Lundell 2006, Benton 2005).

The author argues that the need to use the code will depend on the maturity and standardisation of the software and the level of customisation needed. In the author's understanding, mature and standard software will need less interference with the code. In the same context, standardised software will lead to less customisation. At that point, the advantage of the availability of source code will not be of use. On the contrary, institutions looking for innovative solutions and who are willing to shorten the gap between the production of the software and its usage, will certainly find the availability of the code to be the most important factor in the OSS adoption decision.

2.3.3.3 Support

Many acquisitions and mergers have led proprietary software vendors to drop support for older versions leaving HEI locked in running a proprietary software without the cost of upgrading their system (Wang *et al.* 2010) Using open source software, institutions will benefit from decoupling of software from the support (Wheeler, 2007). This separation, which unlocks support to the software vendor only, gives HEI better options to choose from. Many studies highlighted that organisations will have the ability to choose the most affordable model that aligns with its budget, such as: (a) recruitment of talented permanent staff to provide local support, (b) hire third party support services from a commercial support provider, and (c) buy commercial open source packages which come with support from the vendor (Dedrick and West 2004, Fitzgerald and Kenny 2003, Morgan and Finnegan 2007, Goode 2005).

The HEI will always have the freedom to move from one support model to another, if their needs are not satisfied. They will also, have the freedom to move within the same model from one service provider to another. On the other hand, large institutes can establish a unit with talented staff and outsource the support to other institutions. Meanwhile, group of interested colleges and universities with shared and common interests (i.e. colleges in medical, engineering, commercial sectors) can form a consortium to share knowledge and provide support for all members.

2.4 BENEFITS OF OSS IN HEI

A number of different models exist in the literature to classify the benefits of information systems. As a starting point, the author drew on Machado (2005) framework for the flourishing of OSS in HEI. This framework extends the four-dimensional model for reasoning the proliferation of OSS in HEI of De Praetere (2002) within the domains of education. This model can be adopted for the classification of OSS benefits. Machado (2005) proposes the following classification as presented in table (2.3)

Domain	Reasons
Pedagogical	- Possibility of using different learning scenarios - Web-based learning - Modular and multilingual - Variety of tools
Technological	- Reliable and secure technology - Open architecture - Inter-operational - Open protected copyrights and Licences
Economic	- Eases the burden of software Licence management. - Open Sources cost less to acquire and run than proprietary software - Independence - Generic Product
Philosophic	- Collaborative approach - Anti-monopolistic - Free as education

Table 2.3: Classifications of OSS proliferation in HEI - source: Machaddo (2005)

2.4.1 Pedagogical

One of the most important challenges for e-learning adoption was deemed to be that teachers and instructors had to change their way of carrying out their instruction and learning to be adapted with the tool chosen. With OSS's high level of flexibility, developers can create applications that work the way instructors teach. Meanwhile, the use of OSS for e-learning activities have proved that it can help, enhance, and

complement education by providing tools that promote teaching and learning activities while the standardised educational software packages often fail to meet specific content related needs (Machado, 2005) thus OSS environments bring opportunities to reduce cost whilst nevertheless increasing the use of educational technology. OSS provides idiosyncratic solutions that fulfill specific higher education requirements and also provide a model for collaborative learning and capacity building (Tong, 2004).

In the same context, there is a strong believe that OSS in education provided developing sustainable economics and advancing the frontiers of innovation (Moyle, 2004). In her recent study among 285 higher education institutions in the U.S.A., Williams van Roij identified the main benefits of OSS in e-learning to be the ability to support engaged learning and to create a high challenge low threat learning environment (van Rooij, 2011).

More specifically, for computing schools (i.e. schools of information systems, computer sciences, etc.) teaching the code will enhance students learning activities and give them the opportunity to collaborate internationally with other students and professionals working in collaborative environment. Open source uses the power of collaboration to provide students with hands-on learning and to equip them with an expanded skill set that is very attractive to businesses (Whitehurst 2009, Whitfield 2008). Such a scenario will: (1) enhance students programming skills, (2) offer students opportunities to work and learn at the same time, and (3) provide the society with more talented and skillful staff.

2.4.2 Technological

Open source drives faster innovation, due to its collaborative nature and community-backed effort. Coppola and Neelley (2004) recognised that software design patterns, development technologies, and standards evolved in a way that facilitates modular, interoperable software components to be technical advantages for OSS in higher education. Other studies have identified various technological benefits of using OSS in higher education to be ability to tailor the software (Customisation - Felxibility) (Glance

et al. 2004, Lakhan and Jhunjhunwala 2008, AlMarzouq *et al.* 2005), easily and freely audit their systems, auditability (Olla, 2007) Continuous improvement (Lakhan and Jhunjhunwala 2008), potentially better support (Glance *et al.* 2004, AlMarzouq *et al.* 2005)

2.4.3 Economical

As discussed in previous sections, cost effectiveness and the lower TCO are the major benefits for organisations and HEI to adopt OSS (Khelifi *et al.* 2009, Benton 2005, AlMarzouq *et al.* 2005, Yalta and Lucchetti 2008, Ajila and Wu 2007, Glance *et al.*, 2004). From another perspective, the academic institutions can add to the OSS community by embedding source code teaching in the curriculum. This will create more groups of people interested in the OSS, which will enrich the global OSS movement and lead to the availability of more work forces for the development of OSS. Meanwhile, providing HEI with group of students ready to work for the support and development of OSS projects in the institution itself develops a market in which HEI act as producer and consumer at the same time which results in more cost saving (Machado, 2005).

Moreover, HEI producing OSS has the opportunity to sell customizations and code modifications to other institutions and sell support services too. In the same context, the increase in the number of HEI adopting this scenario will increase the size of OSS in the society leading to more productivity and lower cost for deployment, maintenance and support. This will result in further economical benefits from OSS adoption in public administration and higher education.

2.4.4 Philosophical

There is common philosophy and core values that create a culture which fits between higher education and open source. Creating and sharing knowledge for public good is a key part of the mission of colleges and universities, and a core part of the philosophy favouring open source software (Coppola and Neelley, 2004). Similarly, Wheeler (2007) assures that the behaviours of staff in OSS community align with the core values of higher education, which are steeped in discovery, knowledge sharing, and scholarly

communities. Using the case study method, Burdt and Basset (2005) investigated the motivations and decision-making rationales of eight senior information technology (IT) administrators in the higher education domain. Study participants thought that the cultural fit between open source as a social movement and public education was one of the reasons for institutions of higher education to explore open source software. Table 2.4 classifies benefits of OSS in HEI

Domain	Reasons	References
Pedagogical	Accessibility to knowledge.	Khelifi *et al.* 2009
	promote teaching and learning activities	Machado, 2005
	model for collaborative learning and capacity building	Tong, 2004
	developing sustainable economics and advancing the frontiers of innovation	Moyle, 2003 Dewever, 2006
	support engaged learning and to create a high challenge low threat learning environment	van Roij, 2011
	equip students with an expanded skill set that is very attractive to businesses	Whithurst, 2009
Technological	Ability to tailor the software (Customisation - Flexibility)	Glance, 2009 Lakhan, 2008 Al Marzouk, 2005
	The development team is large, Security is enhanced, Continuous improvement and Software evolves more rapidly and organically	Coppola and Neelley, 2004 Lakhan, 2008
	potentially better support	Glance, 2009 Al Marzouk, 2005
	Easily and freely audit their systems, auditability	Olla, 2007
Economic	Cost effectiveness.	Khelifi *et al.* 2009 Bentone, 2005 Al Marzouk, 2005 Yalta, 2008 Ajila, 2007 Glance, 2009
	The absence of Licence fee	Lakhan, 2008
	Model where HEI become producer and consumer at the same time shortening the gap between developing and using of software.	Machado, 2005 Wheeler, 2007 Brooks, 2007
Philosophic	Collaborative Approach	Sahraoui, 2010
	Culture fit and aligned behaviour between OSS communities and higher education core values.	Burdt and Bassett , 2005 Wheeler 2007 Olla, 2007
	Paragon in facilitating the provision of education	Rajani *et al.* 2003

Table 2.4: Classification of OSS benefits in HEI

2.5 BARRIERS TO OSS IN HE

The previous section discussed several possible benefits of OSS adoption in HEI. However, some of these benefits may also be perceived as barriers (Ven and Verelst, 2008). For example costs are usually thought to be a benefit of OSS adoption. While OSS has been seen to enable reducing TCO, calculating TCO might be time and resource consuming which could result in additional expenses that could hinder the adoption process. Furthermore, community participation has been seen in previous sections to be a point of attraction for open source adoption. However, HEI might need to spend resources on community participation, they may also need to spend a certain amount of money to train staff and encourage them to participate in communities. Moreover, certain countries could lack talented support for organisations who would need premium professional support (Ozel, *et al.* 2007).

Much of the researches surrounding barriers to OSS adoption have been studied (Ven and Verelst 2010, Hauge *et al.* 2010, Cromie and Ewing 2009, Cassell 2008, Morgan and Finnegan 2007, Holck *et al.* 2005). By contrast, there is a paucity of research literature on the barriers of OSS adoption in e-learning in HEI specifically. While the majority of literature focused on the barriers to infrastructure OSS adoption in HEI (i.e. Operating systems, servers, database, web servers) there is a lack of research on barriers to OSS related to e-learning (i.e. integrated learning environment including operational, learning, and supportive software). This is primarily due to the novelty of the OSS e-learning phenomenon.

However, few studies have identified the following barriers to OSS adoption for e-learning implementation in higher education: (a) the difficulty in calculating the true cost of ownership of OSS LMSs, (b) the lack of formal support mechanisms, (c) the need for highly skilled technical personnel, and (d) the lack of efficient tools for migrating from commercial LMSs (Khelifi *et al.* 2009, van Rooij 2007, Molina 2006). Similarly, Albarrak *et al.* (2010) in their study in a medical education school have identified that the lack of skillful development team could be a barrier to adoption of OSS LMSs in medical education in particular and in other sectors of higher education in general. Moreover, they noticed that it is vital to have this skillful team on a permanent

basis and not to be outsourced. This is supported by other studies like (Goode 2005, West and Dedrick 2006, Dedrick *et al.* 2008) which reported that less reliable technical support available from either third party vendors or OSS community is considered to be a critical barrier to OSS adoption.

2.6 Opportunities for Developing Countries

OSS has a direct impact on economic values by virtue of its capacity for creating new opportunities and new business models (Machado, 2005). Coppola and Neelley (2004) noted that OSS opens new business model for societies. The OSS offers new companies to be established to use the software to offer products and services of value to others. Businesses based on open source software typically add value by: (1) Offering services such as implementation, training, and support; (2) Packaging and integrating open source software to make its installation and use easier for a wider market; and (3) Creating complementary, add-on, or enhanced software for sale.

As discussed in previous sections, the open source development community provides an environment of intensive interactive skills development at little cost. This is particularly useful for local development of skills, especially in economically disadvantaged regions. Further, Ghosh (2003) argues that the controversy over total costs of ownership (TCO) of free versus proprietary software is not applicable to developing countries and other regions with low labour costs, where the TCO advantage lies with open source, and the Licence fees in proprietary software is much greater than in high labour cost countries.

According to the Treasury Board of Canada Secretariat, "The strategic rationale for national migrating to OSS is typically related to three main factors: 1) the expectation of direct cost savings, 2) the reduction of economic loss at the national level caused by proprietary software imports, and 3) the hope to better develop national IT expertise by means of access to source code" (Charpentier and Carbone, 2004). The OSS model can offer developing countries many potential benefits to decrease the cost of IT acquisition

in public administration and public education, increase its software exports (increasing job opportunities in new business models), and decrease its software imports

For local governments, OSS represents a valuable way to gain independence from single suppliers, keeping the main information technology expenditures at home and participating in a promising local software industry. It carries with it the hope of improving indigenous human resources capacity and the country's technical base. This 'ownership' also provides the possibility to influence the direction of its development, and new local features, such as the development of user interfaces in local languages. In fact, the accessibility and possibility to rewrite source code can signify by itself a kind of wealth transfer to any nation and can have a positive dynamic impact on the country's economy. Many developing countries have considerable potential in terms of low-cost, specialised labour. In combination with OSS, this potential produces an advantage that is significant at a national level as well as, in some circumstances, at international level.

OSS opens the door for developing country users to customise applications according to the local market specifications, and encourages the normal growth of applications within particular contexts. In addition, access to the source code provides, for software development communities in developing countries, an insight into the proprietary software development process and a chance to improve their skills based on such participation.

2.7 CHALLENGES FOR DEVELOPING COUNTRIES

Despites the opportunities and benefits of applying the OSS movement in developing societies and communities, the widespread of OSS faces many challenges that are summarised below:

2.7.1 Lack of local OSS talents

Previous sections have discussed the role of OSS communities in providing support and technical assistance to the adopters of OSS, and how the lack of such communities beside skilful personnel could present a barrier to OSS adoption especially in higher education domain. The involvement of a knowledgeable team member, external consultant, or service providers to assist HEI to adopt OSS and growth is becoming crucial to successful implementation. van Rooij (2009) and Albarrak *et al.* (2010) recognised the recruitment and retention of the IT staffing and talent required to develop and manage secure open source applications as critical to OSS adoption. According to Wheeler (2007) the demographics of the open source community which is: overwhelming male, prodomintly young, concentrated in the United States and Europe, IT professionals, mostly college and high school graduates, and part time participants. There is a need to raise awareness between students and professional to the OSS movement, encourage new business model to support the software and provide new job opportunities and thereafter a solid community of supporter.

2.7.2 OSS Governmental Policies

Indeed, most of the developing countries are lagging behind in the open source movement. Out of a total of 275 OSS government initiatives in the world, only 8 are from Africa and the Middle East with many not acted upon (Lewis, 2007). This lack of government policy hinders the OSS adoption in developing countries. Thus, Dewever (2006) argues that governments should develop policies that promote the use of open standards and to promote interoperability. (Comino and Manenti, 2005) identify three ways government policies may impact the adoption of OSS: (1) mandated adoption, (2) information provision, and (3) subsidies.

2.7.3 ICT convergence and governance

One of the most challenges that affect the introduction of OSS is related to the ICT convergence in higher education in developing countries. Despite huge efforts in implementing ICT for teaching and learning processes, universities still face lots of challenges in undertaking such a process. Many studies have identified factors needed

to overcome OSS e-learning to be a success such as: (1) lack of computing equipment, (2) lack of institutional support, (3) disbelief of technology values and benefits, (4) lack of personnel confidence in technology, and (5) lack of time for the academic staff to learn and implement technology in their curriculum (Ali and Magalhaes 2008, Al-Senaidi *et al.*2009, Sife *et al.* 2007). In the same context, the lack of ICT governance leads most likely to OSS failure in HEI (Sahraoui, 2010). In the absence of proper ICT governance in developing countries HEI, the adoption of OSS is left to personal judgments and to the power of the decision maker amongst users, IT administrators, and university management.

2.7.4 Procurement and selection

OSS is a new phenomenon and the use of OSS in e-learning is still unexplored. Furthermore, due to the complexity of e-learning adoption in general and OSS in particular, the selection and procurement process of OSELA is becoming very crucial task. There is a clear need for the involvement of a knowledgeable and well-informed procurement team to be able to assess and evaluate the available applications. The lack of such teams and knowledge in the domain of higher education in most of the developing countries increases the challenge of OSELA adoption. Furthermore, Hilding-Hamann and Massy (2004) claim "poor quality procurement practices (in all sector and especially in the public sector) are a barrier to growth and adoption".

Dewever (2006) calls for the adoption of a rigorous evaluation, selection, and procurement process that balances cost and technical criteria with non-technical criteria of end users. On the other hand, there is a need for policymakers to support the improvement of public HEI procurement in relation to the purchase of e-learning. Public HEI should aim to select and operate highly flexible, vendor independent, interoperable ICT architectures, which are responsive, open to new technological developments and value-driven (Legner and Wende, 2006).

2.8 REVIEW

This chapter attempts to review the normative literature to identify research issues relevant to the adoption of OSS by HEI. In doing so, the author determines a gap in literature dealing with the absence of theoretical models for OSS adoption. The justification for this is that open source e-learning application is a new research area. In addition this chapter provides background knowledge of issues that can influence the adoption of OSS by HEI. This provided an initial scope of issues relevant to the research objective to explore and understand factors that influence the adoption of OSS by HEI.

In order to enhance our scope of exploration and understanding of OSS adoption by HEI, it is argued that mature and proven theories on ICT adoption can be applied. This approach will provide an opportunity to use a suitable and proven theory that can enable better exploration and understanding of OSS adoption by HEI. This approach will be used in the next chapter, where knowledge gained in this chapter will be applied in evaluating and selecting a suitable theory for better exploring and understanding OSS adoption by HEI for e-learning.

Chapter 3

Open Source E-Learning Application Adoption Model

Chapter 3. Open Source E-Learning Application Adoption Model

The main research issue derived from Chapter 2 is that there is an absence of research and theoretical models that describe the adoption of open source applications for the construction of an integrated e-learning application in higher education institutes. There is a large open source application variety that covers different HEI administrative, technical, and academic needs, but none of these applications combine all features and requirements needed from HEI to implement a totally integrated e-learning environment. Moreover, since a diversity of those applications exist, there is confusion surrounding the best use of those applications, along with an increasing need to know how to evaluate them in order to choose the best applications that can share a common, managed set of features satisfying and accommodating the ever-changing needs of HEI. Therefore, in order deploy an integrated e-learning environment, there is a need to piece together different open source e-learning applications and integrate them to fulfill all HEI requirements.

The implementation and deployment of OSELA is a very complex procedure. It requires commitment from the project team, college's management, and sustainable funding and resources. The evaluation criteria of any open source application must first start with an understanding of the goals of the institution. There are potential trade-offs to consider when assigning weights to these criteria, which could be determined by the college's vision and strategy.

The aim of this chapter is twofold: (a) to attempt to clarify the confusion surrounding the use of open source application in the e-learning area and, (b) to conceptualise a model for the adoption and evaluation of OSELA. The author addresses the first aim, by suggesting an evaluation framework for the assessment of OSELA in Higher Education. The framework is based on a set of evaluation criteria that clarify much of the confusion surrounding OSELA. Thereafter, the evaluation framework is used as part of a novel conceptual model that is suggested for OSELA adoption. The suggested model contributes to open source and e-learning adoption area, as it includes a number of factors which influence OSELA adoption.

3.1 NOVEL TAXONOMY FOR CLASSIFYING TYPES OF OSELA

Over 62,000 open source projects reside on large open source public repositories (like SourceForge[1], SchoolForge[2], FreshMeat[3], and EduForge[4]). There are various open source solutions available when it comes to developing a virtual university. According to Source Forge the number of registered open source projects specifically intended for the education sector are 5,235 projects and applications (SourceForge, 2010). Those educational projects focus on a variety of solutions for all level of education such as portals, classroom testing and assessment, library systems, learning management systems and content development and authoring tools among other applications.

[1] www.sourceforge.org
[2] www.schoolforge.net
[3] www.freshmeat.net
[4] www.eduforge.org

At higher education level, many applications such as research administration, conference management and journal administration systems are also available as open source software. However, as discussed in chapter two, no single e-learning application addresses all HEI requirements and there is an increasing need to have an integrated e-learning platform. This platform contains a set of applications that share a common, managed set of features satisfying the specific HEI e-learning needs. Having discussed the need for integrated OSELA, this section analyses the types of open source applications that are unified through OSELA.

Different classifications in the open source area has led to confusion regarding open source applications which can be integrated through OSELA to implement e-learning in HEI, as each classification suggests the inclusion of different types of application. Clearly, there is a need to clarify this confusing classification and define different types of open source applications needed for e-learning implementation in HEI. In addressing the aforementioned need, a novel taxonomy is proposed by the author, which will clarify this confusion.

The taxonomy is based on the analysis of normative literature on open source software in higher education. The novelty of the taxonomy focuses on the combination of a comprehensive set of applications that describe the higher education requirements for e-learning implementation. The proposed taxonomy will allow decision makers and implementers to better understand OSELA and can be used as a tool for decision-making. It will also allow academics and technologists to interpret and apprehend the capabilities of OSELA. Therefore, it increases understanding that OSELA unifies campus wide applications and as a result leads to the development of an integrated infrastructure that supports e-learning implementation. Therefore, the proposed taxonomy helps HEI decision makers and managers adopting OSELA for e-learning implementation in the higher education sector.

According to Ozkan (2008) one of the early research studies on Free and Open Source Software (FOSS) was sponsored by the European Commission in 2002 and aimed at

better understanding its use by business and government institutions classified the use of FOSS in four major areas: operating systems (Linux), databases (MySQL), creating and operating websites (Apache, Perl, PHP), and desktop applications (Firefox, OpenOffice). In 2003, Taylor clarifies that the Information and Communication Technology (ICT) convergences in higher education encompasses the convergence of administrative systems with the emerging technologies of online learning (Taylor, 2003).

While Tong (2004) categorised the use of FOSS in Education into 2 categories: infrastructure (including servers' software and desktop applications) and administration (include all management systems). Similarly, Abel (2006) in his study has categorised FOSS into infrastructure products and open source compatible application. In the same context, Glance *et al.* (2004) found OSS integrated at all levels of university operations, which are: administration, teaching, laboratory, and research. Wheeler (2007) believes higher education applications reside in four categories: (a) administrative, (b) infrastructure, (c) teaching and research and (d) scholarly repositories/libraries.

For the purpose of this thesis, the author drew on Wheeler's approach. The author believes that all applications with direct relation to the core business of education, which is disseminating knowledge and ensuring learning occurrence should be grouped in one classification as they directly affect the education of students. In today's networked web-based environment, digital library and scholarly repositories are becoming a primary source of scholarly research and educational textbooks. E-libraries reflect directly on the knowledge building of any learner. Therefore, the author group scholarly libraries and repositories to the teaching and research class under the classification of learning. Meanwhile, there are many other systems that are not in direct relation to the learning process but support learning activities in higher education sector. Systems that support research, conference management, journal administration, portal customisation and office productivity are classified by the author to be supportive for e-learning activities in higher education sector.

The objective of this categorisation is to highlight the learning and supportive applications and to allow better evaluation and selection to the applications that form the core activities of e-learning. The adapted categorisation classifies the open source applications used in HEI into four main categories namely:

1. Learning Applications;
2. Supportive Services;
3. Business Services; and
4. Infrastructure Applications.

These categories of applications are summarised below since the suggested framework in section 3.5 addresses the assessment of these applications. The summary below will give the reader a chance to gain a better understanding of the evaluation framework.

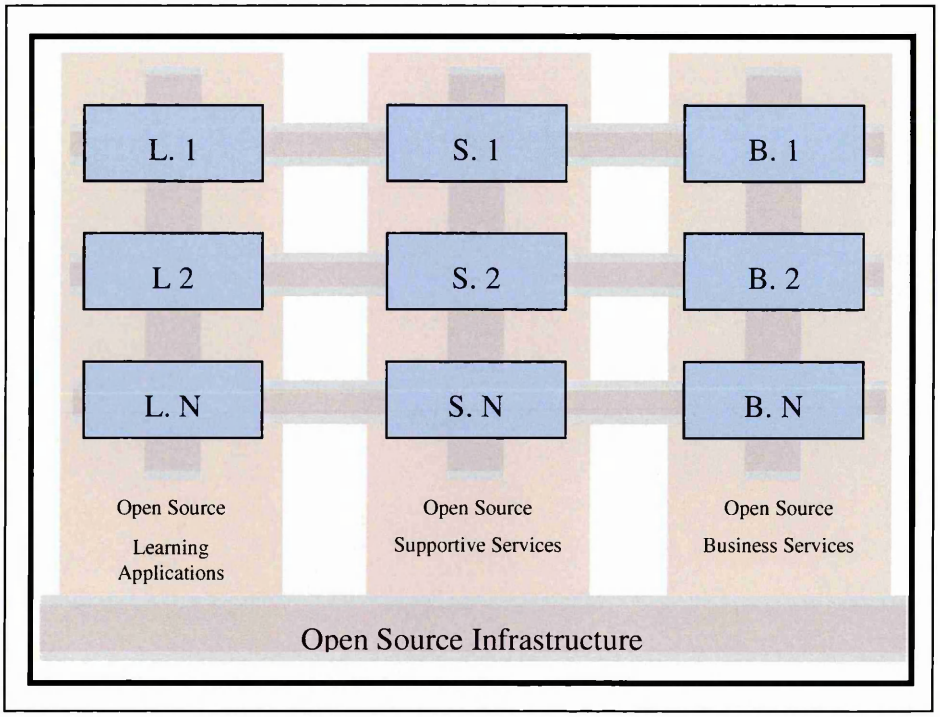

Figure 3.1: Novel Taxonomy for Open Source E-Learning Application

3.1.1 Learning Applications

Many researchers conceive e-learning to be the learning management system (LMS). Many started evaluating the usage of those systems from many perspectives, and assessments were held in the normative literature to distinguish one system from another. One of the reasons for this dilemma is that learning management systems form the core of education and e-learning. The majority of LMS's contain modules and features that are directly related to the process of teaching and learning. LMS is among the most visible user experience by campus IT. Users' perceived satisfaction with course management systems clouds their perception of IT services quality (Wheeler, 2007). Moreover, many universities and colleges claim that they have introduced e-learning to their educational system once they have deployed their LMS and uploaded a number of educational materials to it.

Open source software has marked a noticeable success in the area of LMS. Many OSLMSs are well designed, widely supported, periodically enhanced and improved, and have features and capabilities to cover most HEI learning needs (Lakhan and Jhunjhunwala 2008, Coppola and Neelley 2004). Many universities have decided to move from expensive proprietary LMS to OSLMS especially after the later reported a success in many areas and disciplines.

However, in HE many educational processes are not totally covered by LMS alone. Applications such as Research Administration Systems, Conferences Management Systems, Journal Administration Systems, Portfolio Management Systems, and e-Library Management Systems are too complex to be incorporated in a general LMS. These systems represent major activities that are essential in the learning outcomes of students in higher education at both graduate and postgraduate levels. The availability and "free" use of the code, sharing the same programming language and the homogeneous building infrastructure for most of the above mentioned applications made it simple to integrate all different applications into one single portal that could be accessed simultaneously by administration, students, and teachers. The following sections describe the main applications in the learning category.

Learning management system

A learning management system (commonly abbreviated as LMS) is a software application for the administration, documentation, tracking, and reporting of training programmes, classroom and online events, e-learning programmes, and training content. The primary objective of (LMS) is to manage learners, keeping track of their progress and performance across all types of training activities.

E-Library Management Systems

An e-library management system is an enterprise resource planning system for a library, used to track items owned, orders made, bills paid, and patrons who have borrowed. A simple library management system has administrative user interface that provides the following facilities: login, register, add category, add / remove book, search / issue book, return book. In the same context, an E-library is connected to online scholarly open databases and publisher to provide teachers, students and researchers the accessibility to rich educational and research materials.

Social Learning Systems

Social Learning Systems encompasses a range of software systems that allow users to interact and share data. This computer-mediated communication has become very popular with social sites such as MySpace and Facebook, and media sites such as Flickr and YouTube. Many of these applications share characteristics like open APIs, service-oriented design and the ability to upload data and media. The terms Web 2.0 is also used to describe this style of software.

Portfolio Management Systems

The concept of developing portfolio management systems is based on the fact that the reflective practice of creating portfolios enables students to document and track their learning; develop an integrated, coherent picture of their learning experiences; and enhance their self-understanding (Bhattacharya and Hartnett, 2008). This process

enables the students to plan and proceed towards their future goals and allow them to showcase their skills and knowledge to prospective employers and research supervisors.

3.1.2 Supportive Services

Portal Administration

Portal Administration System is a framework for integrating information, people and processes across campus boundaries. It provides a secure unified access point, often in the form of a web-based user interface, and is designed to aggregate and personalise information through application-specific portlets. IT enables easy, standard-based integration with authentication and security infrastructures, single sign-on secure access, campus applications, web-based content, and end user customisation.

Research Administration

In Higher Education Institutes, research plays a huge role in faculty activities. Research administration systems manage the complexities of research administration that fully addresses the needs from the faculty researcher through grant administration to funding agencies, associations, and bodies.

Conference Management

Conference Management system is a publishing tool which will create a complete web presence for a scholarly conference. It allows to: create a conference web site, compose and send a call for papers, electronically accept paper and abstract submissions, allow paper submitters to edit their work, post conference proceedings and papers in a searchable format, register participants, and integrate post-conference online discussions

Journal Administration

Journal Administration System is publishing systems that expand and improve access to research. It assists with every stage of the refereed publishing process, from submissions through to online publication and indexing. It may allow Editors configure

requirements, sections, and review process. For the subscriber it allows online submission, management of all content and subscription module as well as comprehensive indexing of content.

3.1.3 Business Services

Colleges and universities require effective business services and applications to manage student registration and enrolment, degree audit, financial management, quality assurance, classes and facilities booking and reservations, employee's administration (including teachers, assistants, and administrations) and other student and teaching related administrative processes and services. Recently, user expectations for easy-to-use, on-line services have increased and the quality of these services has become a significant differentiator for students and faculty. The availability of these systems is crucial as they form the baseline for any e-learning initiatives even though they do not contain any learning components.

Moreover, Stoltenkamp *et al.* (2010) explored major challenges regarding a lack of a backend mechanism and business process to support the open source LMS. In the same context, Wheeler (2010) noted the importance of rapid provision of business services and localising them to face the rising expectation of users and the ensure continuity of the distance education offerings

> *"No dean wants to hear that he or she cannot implement a new distance-education offering because the administrative software is not able to enroll and bill students for a particular degree programme innovation"*
>
> (Wheeler, 2010)

It is evident that a lack of backend support could lead to a break-down of the e-learning front-end support structure and respectively to the usability of e-learning project as a whole.

The information systems required by many Higher Education Institutions today are similar to components within large and complex Enterprise Resource Planning (ERP) systems used in industry and are generally very expensive to implement and maintain. These systems also make it difficult and expensive to support differentiated processes and services that reflect different types of institutions, with different goals and missions. Some institutions have developed their own in-house systems. Yet, they fear an increasing financial and technical risk in continuing to develop and support these systems on their own. The availability of the open source administrative applications raised the opportunities for those HEI who are not able to use modular systems components as an alternative to the installation of a large, monolithic ERP system and to those with existing in-house systems to incrementally replace them with more mature and modular ones.

Financial Management Information Systems

With the academic environment becoming more computerised, the need for computerised financial systems is great. The financial Information Systems enables the institution to run evaluations for the general ledger, accounts receivable, and accounts payable. IT also ensures that an institution management information system and accounting information system work together to meet the information needs of management.

Facility and Classroom Management Systems

Facility and Classroom management systems are used to assist in the scheduling of classrooms. It is intended for colleges to avoid conflicts when scheduling courses and professors into classrooms using particular timeslots. It solves the most challenging problems of room, resource, and facilities allocations.

Student Information System

A Student Information System is a software application for education establishments to manage student data. Open source Student Information Systems are often web-based and provide capabilities for entering student demographic information, scheduling,

grade book, attendance, report cards, eligibility, transcripts, student portal and many other student-related data needs in a school, college or university. Currently, major projects related to online Student Information Systems (SIS) are directed to be used in online learning environments and focus on encompassing all activities required to assist in the implementation of e-learning initiatives. These projects have the capability to administer the learning process varying from blended e-learning programmes to fully automated self-Based programmes.

Human Resources Management Systems

Human Resource Management System refers to the information systems that cover the total cycle of Human Resources (HR) and payroll systems; it starts from recruiting until the retirement of employees (teachers, assistants, lecturers, administrators, etc.). It covers Personnel Information Management, Employee Self Service, Leave, Time & Attendance, Benefits, and Recruitment.

3.1.4 OS Infrastructure

Today's digital-ready teachers and students—and their expectations for college and university IT services - expect integration among systems with personalised views of their data. Fortunately, OSELA addresses these needs successfully. The availability of Open Source software in areas such Identity Management System and Unified Communication Systems meet the expectations of today's students in having a rich learning experience and a very simple way to blend their modern life style with their educational activities and learning experiences.

On the other hand, Stoltenkamp *et al.* (2010) identified evidence of a continuum (2005-2010) of highlighting repeated e-learning system crashes; and further emphasised how an instructional design team is dependent on sound infrastructures in order to deliver effective pedagogical training and support.

Identity Management System

Identity Management System is a standard based software package for web single sign-on across or within campus boundaries. It allows different internal sites (or sub-domains) to make informed authorisation decisions for individual access of protected online resources in a privacy-preserving manner. On the other hand, it allows a user to provide his or her credentials once in order to access multiple applications. This single sign on process authenticates the user to access all the applications he or she has been authorised to access. It eliminates future authentication requests when the user switches applications during that particular session.

Unified Communication Systems

Unified Communication System is a complete institution wide application. It integrates real-time communication services such as instant messaging (chat), telephony (including IP telephony), video conferencing, and call control and speech recognition with non-real-time communication services such as unified messaging (integrated voicemail, e-mail, SMS and fax). The integration of those set of products provides a consistent unified user interface and user experience across multiple devices and media types, offering email, calendaring, contacts, tasks, document management, synchronisation with cell phones and full-text search.

3.2 Open Source Applications Requirements

One of the main challenges for using OSS is evaluation and selection of the most appropriate software from many available in the market (Maki-Asiala and Matinlassi 2006). Procurement and adoption of OSS employ evaluation frameworks to ensure comprehensive coverage of the factors affecting the adoption processes. To overcome this challenge, many researchers have proposed various evaluation and selection approaches and frameworks to assist decision makers selecting appropriate OSS application that satisfy the ever-changing needs and requirements of customers. Different frameworks use different methods to evaluate OSS like: Capgemini Open Source Maturity Model (Duijnhouwer and Widdows, 2003), Navica Open Source Maturity Model (Golden, 2004), Evaluation Framework for Open Source Software

(Koponen, 2006), Method for Qualification and Selection of Open Source Software (QSOS) (Origin, 2006), Open Business Readiness Rating (OpenBRR) (Wasserman *et al.* 2006), Framework for OS Critical Systems Evaluation (Ardagna *et al.* 2007), An Operational approach for selecting open source components in a software development project (Majchrowski and Deprez 2008), and OpenSource Maturity Model (Petrinja *et al.* 2009).

The importance of evaluation frameworks has increased with the shift to online delivery of courses, and many researchers suggested selection and procurement criteria to be put under consideration when choosing an e-learning application (Dewever 2006, Coppola and Neelley 2004). Many comparisons and evaluation frameworks of Content / Learning Management Systems may be found in the educational literature. Most of these frameworks are based on past frameworks to evaluate computer software and were adopted to meet LMS need (Britain and Liber 2005, Buendia and Hervas 2006, Donham 2004, Graf and List 2005). A simple framework to differentiate between different methods of evaluation Virtual Learning Environment (VLE) was proposed by (Dixon MC, 2003). The proposed framework consists of: (a) the purpose of evaluation, (b) type of evaluating method; and (c) applied measures.

While Britain and Liber (2005) suggested a framework for pedagogical evaluation of VLE that was based on two models; one came from the viable system model, and the other from the conversational framework suggested by Laurillard (2002). In 2006, Buendia and Hervas (2006) proposed a framework based on the use of standard specifications that allows instructors the elaboration of benchmarks to evaluate e-learning platforms. Ferl (2005) proposed a model that emphasises three main areas of functionality of any learning platform: (a) Content, (b) interaction "communication"; and (c) management. In her thesis in 2005, Van Den Berg used criteria found in other OSS evaluation and literature like Donham (2004) to propose her model to evaluate OSLMS (van den Berg 2005).

However, most of these frameworks conceived e-learning as one single application (LMS), despite the fact that the market is offering a large product variety each addressing a specific learning needs (Dewever 2006). No single system has the ability to accommodate the ever changing needs of higher education of having a robust integrated learning environment that serves both academic and administrative needs (van Rooij 2009). Universities and colleges want their business systems (Finance, Human Resources, and Student Information Systems) to work with their learning systems (Learning Management System, Content Management Systems, e-library, e-portfolio) and other supportive systems (Authentication and Authorization, Campus Portal, Unified Communication Systems) in an increasingly modular, robust and interoperable manner (Brooks 2007, van den Berg 2007).

In order to make the right decisions while implementing e-learning campus wide application, HEI managers and decision makers should evaluate the entire OSELA and seek the right mix of functionality, interoperability, availability of support and many other factors that ensure their robust adoption and avoid being locked to an application that is difficult to upgrade, maintain or integrate with the whole e-learning system. Katz emphasises the importance of evaluating the entire IT portfolio in order to get the best balance between cost and product survival (Katz, 2006).

Based on an extensive and rigorous review of the literature the author summarises the more commonly used evaluation and selection criteria. These evaluation criteria are presented in Table (3.1). Evaluation and selection criteria summarised in Table (3.1) are important, since decision makers take them into consideration when choosing their OS applications that will be members of the OSELA.

Application Requirements	Description
Maturity	Maturity shows the stability of open source application. It deals with its continuous growth in term of development activities (correcting and improving or enhancing) and community activities (Koponen 2006).
Community	Community is the number of people and organisations existing around open source software and participate in its life-cycle (Origin 2006). Community participation includes: filing bug reports, giving feedback on functionality the user would like to be added and putting the software through extensive testing and Quality Assurance (QA). The size and involvement of the user community indicates the interest in the application (Chavan 2005).
Longevity	The longevity of a product is a measure of how long it has been around. It says something about a project's stability and chance of survival. (Golden 2004) checked Longevity using the following criteria: Age of the product (the date of the first release) and version number
Licence	The Licences in the Open Source world reflect where copyright is used to ensure free software and their derivative works remain free. The most well-known OSS Licence is GPL, which was drafted by Richard M. Stallman, the founder of the Free Software Foundation (FSF) and the Project GNU. Despite most of the products follow (GPL), still there are other Licences such as: Creative Common Licence (CC Licence), Lesser General Public Licence (LGPL), Free Documentation Licence (FDL) and Mozilla Public Licence (MPL)
Support	Support covers several areas: training users on how to use the product, installing the product, and answering users who have specific problems trying to use a working product (Wheeler 2010)
Documentation	Donham claims that rich documentation is the hallmark of a stable and mature OS application (Donham 2004). As community keeps updating and evolving the software, it becomes essential to keep documentation up-to-date and useful for others that often rely on internal resources to deploy, debug and maintain the software (Chavan 2005).
Security	Security is one of the main issues when software is evolved. The openness of open source makes it safer as communities that involve end users, developers, support staff lead vulnerabilities in the code to be found sooner (Wheeler 2010). Security depends

	strongly on how much attention the developers give to it. Evaluating a product's security could be complicated. It depends strongly on how much attention the customers give to it. Different environments often impose different security requirements on the same type of product.
Functionality	Functionality is the ability of the application to fulfil the requirements and meet the business needs of the customer (Wheeler 2007, Donham 2004). It means that the application has the elements, tools, and features required for the business case (Brooks 2007, Dewever 2006). Fortunately, Open Source software that is freely available gives the added option of installing the software which enables the full testing of the functionality. (van den Berg 2007).
Interoperability	Not every software type has applicable standards, and sometimes the formal standards are not used as much as other formats. Interoperability refers to the ability of the application to operate and work with other applications in use or planed to be used. The software architecture should fit the institution's technology and interoperability profile. Any institution's profile often includes a variety of commercial, custom made and open software. Closely connected to standards is the key to interoperability with other applications. The eLearning industry group recommends the adoption of software and applications based on open standards and interoperable systems permitting heterogeneous environments, incorporating software regardless of its development model (e-Learning Industry Group 2009)
Customisability	Customisability measures how well one can customise the product to fit into a specific environment and how well a programme can be used to handle unusual circumstances that it was not originally designed for (Wheeler 2010).
IT and Web profile	The flexibility offered by the software to run on a multiple profile of servers, operating systems and databases is an advantage (Chavan 2005). To avoid unneeded and redundant servers and to keep low cost of ownership, Brooks argues that it is important for the application to have the ability to standardise across hardware, operating systems software and web applications platforms (Brooks 2007).

Table 3.1: Application requirements

3.3 APPLICATION PURPOSE

The higher education industry is idiosyncratic and has many business practices that are unique and essential to the sector (Wheeler, 2007). Many of the previously used vended systems are of little use and do not fulfill the required functionality specific to higher education, and many home-grown systems are increasingly unsustainable (Kuali, 2010). Over the past years, numerous schools have expressed interest in the idea of forming business applications (Financial, Human Resources, and Payroll) specially made for the higher education sector. As one of Open Source software advantages, it is always possible to adapt a general application and modify the code in order to fulfill the requirements of colleges and universities. However, these modifications will need the recruitment of talented staff members or even the rental of development skills from a third party commercial developer. Such an action would increase the total cost of ownership by adding the cost of deployment. Moreover, in some cases extensive modifications could be required. This will delay the time of deployment and might hinder the time of implementation leading to more cost and increasing risks of failure. In the case of selecting general application, HEI have to consider: (a) extra costs (recruit of talented staff, rent of development skills), (b) more time for deployment (development, testing), and (d) Risk of failure (complexity, non-operability). Thus, the author suggests (the purpose of the application) as selection criteria that HEI need to put into consideration.

3.4 NOVEL EVALUATION FRAMEWORK FOR EVALUATING OSELA IN HEI

As seen from the previous sections of this dissertation, there is confusion surrounding Open Source applications used in learning in HEI. In addressing this issue, the author suggests the development of an evaluation framework to help decision makers within HEI to select the applications that will form the open source e-learning application (OSELA). To the best of the author's knowledge, this is the first study into OSELA adoption in public HEI, although there have been several studies of OSS adoption in public organisations (Rentocchini and Tartari 2010, Lundell 2006, Rossi *et al.* 2006,Ven *et al.*, 2006,Ven *et al.* 2007) and OSLMS evaluations frameworks (Dixon 2003, Britain

and Liber 2005, Donham 2004, van den Berg 2005, van den Berg 2007, Buendia and Hervas 2006).

However, most of these frameworks were used on a single dimension only: either product (LMS) or software (OSS). Moreover, these frameworks were conducted in a developed country context. Such frameworks may not be suitable for use in a developing country context where factors such as the robustness of the communications infrastructure, capacity of teachers to use technology, students' access to technology, the affordability of technology, and a range of other factors can have a much greater impact on students' learning experiences. Because each institution is unique, there is no single OSELA that is right for everyone. Olla proposed that the evaluation of e-learning systems should be aligned with each institution's vision, strategy and goals as there are potential trade-offs to consider when and determining assigning weights to the evaluation criteria (Olla, 2007). However, the author argues that the decision factors of product evaluation, institutional values and availability of talented support are common to all.

The current section will present a novel evaluation framework specially designed and developed for the purpose of evaluating OS applications used in e-learning integrated platform. The novelty of the framework relies on the usage of combination of criteria that describes the effective use of different Open Source Applications in deploying e-learning in Higher Education Institutes. As it has been discussed in chapter 2 of this dissertation, the integrated e-learning platform could be supported by applications that fulfill: (a) OS applications requirements, (b) e-Learning modes and, (c) Application Purpose. These criteria are presented in Table (3.2)

Category	Criteria
E-Learning modes	1. Blended e-learning 2. Online Blended e-learning 3. Self Based e-learning
Applications requirements	1. Maturity 2. Community 3. Longevity 4. Licence 5. Support 6. Documentation 7. Security 8. Functionality 9. Interoperability 10. Customisability 11. IT and Web profile
Application Purpose	1. General 2. Education Focused 3. Industrial Focused

Table 3.2: Evaluation Criteria

The author uses the scale of ranking used by Miles and Huberman (1994) to assess the different applications. The ranking of applications follows a high (●), medium (◉), and low (○) scale of ranking. In addition to mark the applicability and non-applicability, two symbols are used. The symbol (✓) indicates applicable, while the symbol (✗) indicates not applicable and the value (Grey shade) indicates that there is no available information regarding the issue under evaluation.

		Applications Requirements											Application Purpose			e-learning mode		
Category	**Applications sub category**	IT and Web profile	Customisability	Interoperability	Functionality	Security	Documentation	Support	Licence	Longevity	Community	Maturity	Industrial Focused	Education Focused	General	Blended e-learning	Online Blended e-learning	Self Based e- Learning
Learning	Learning management system																	
	e-Library Systems																	
	Social Learning Systems																	
	Portfolio Management Systems																	
Supportive	Research Administration																	
	Conferences Management																	
	Journal Administration Systems																	
	Portal Administration Systems																	
	Office Productivity & Web Browsers																	
Administrative	Student Information System																	
	Facility and Class Management																	
	Financial Management																	
	Human Resources Management																	
Infrastructure	Operating Systems																	
	Identity Management System																	
	Web Servers																	
	Database Servers																	
	Unified Communication Systems																	

Table 3.3: Novel Evaluation Framework for the selection of Open Source E-Learning Applications

3.5 A NOVEL MODEL FOR THE ADOPTION OF OSELA

The author attempts in the following section to contribute the areas of e-learning and open source adoption by proposing a novel model for the adoption of open source e-learning applications. While adoption of IS innovations has been extensively studied (Basole 2008, Venkatesh *et al.*2007, Venkatesh *et al.* 2003). Bhadauria *et al.* (2009) noted very few research studies have investigated the adoption of OSS, which is primarily justified due to the novelty of the OSS phenomenon.

Drawing on IS body of research, OSS adoption can be investigated using many different theoretical lenses. Agency theory and transaction cost economics provide explanations from an economic perspective, while Adaptive Structuration theory, Diffusion theory, Institutional Theory, and Social Network theory may be used to understand OSS adoption from a sociological perspective (Rogers 1995, Niederman *et al.* 2006). The Technology Acceptance Model (TAM) (Venkatesh *et al.* 2003, Davis *et al.* 1989) holds a preeminent place in the IS adoption literature because of its simplicity and explanatory power to explain individual user's adoption behaviour. DeLone and McLean (1992) proposed the model of IS success both at individual and organisational levels. This model was later updated to include Service Quality (Delone and McLean, 2003).

Similarly, several frameworks have been suggested in the extant literature to study IS innovation. Preeminent among these is Swanson's Tri core model, which offers an integrative framework to study IS innovation and adoption (Grover *et al.* 1997). Using Adaptive Structuration Theory as a framework, researchers have examined the influence of organisational structure and technological structure on each other (DeSanctis and Poole 1994). Niederman *et al.* (2006) suggested a multi-level framework to study OSS.

For the aim of this thesis, the interest is in theories about technology adoption. The most used theories are the technology acceptance model (TAM) (Davis 1986, Davis 1989, Davis et al. 1989), theory of planned behaviour (TPB) (Ajzen 1985, Ajzen 1991), unified theory

of acceptance and use of technology (UTAUT) (Venkatesh et al. 2003), DOI (Rogers 1995), and the TOE framework (Tornatzky and Fleischer 1990). The following sections will develop only the DOI, and especially the TOE framework, because they are the only ones that are at the organization level. The TAM, TPB and UTAUT are at the individual level.

DOI is a theory of how, why, and at what rate new ideas and technology spread through cultures, operating at the individual and firm level. DOI theory sees innovations as being communicated through certain channels over time and within a particular social system (Rogers 1995). Individuals are seen as possessing different degrees of willingness to adopt innovations, and thus it is generally observed that the portion of the population adopting an innovation is approximately normally distributed over time (Rogers 1995). Breaking this normal distribution into segments leads to the segregation of individuals into the following five categories of individual innovativeness (from earliest to latest adopters): innovators, early adopters, early majority, late majority, laggards (Rogers 1995). The innovation process in organizations is much more complex. It generally involves a number of individuals, perhaps including both supporters and opponents of the new idea, each of whom plays a role in the innovation-decision.

Based on DOI theory at organizational level (Rogers 1995), innovativeness is related to such independent variables as individual (leader) characteristics, internal organisational structural characteristics, and external characteristics of the organisation (Figure 1). (a) Individual characteristics describe the leader attitude toward change. (b) Internal characteristics of organisational structure includes observations according to Rogers (1995) whereby: "centralisation is the degree to which power and control in a system are concentrated in the hands of a relatively few individuals"; "complexity is the degree to which an organisation's members possess a relatively high level of knowledge and expertise"; "formalisation is the degree to which an organisation emphasizes its members'

following rules and procedures"; "interconnectedness is the degree to which the units in a social system are linked by interpersonal networks"; "organisational slack is the degree to which uncommitted resources are available to an organisation"; "size is the number of employees of the organisation". (c) External characteristics of organisation refer to system openness.

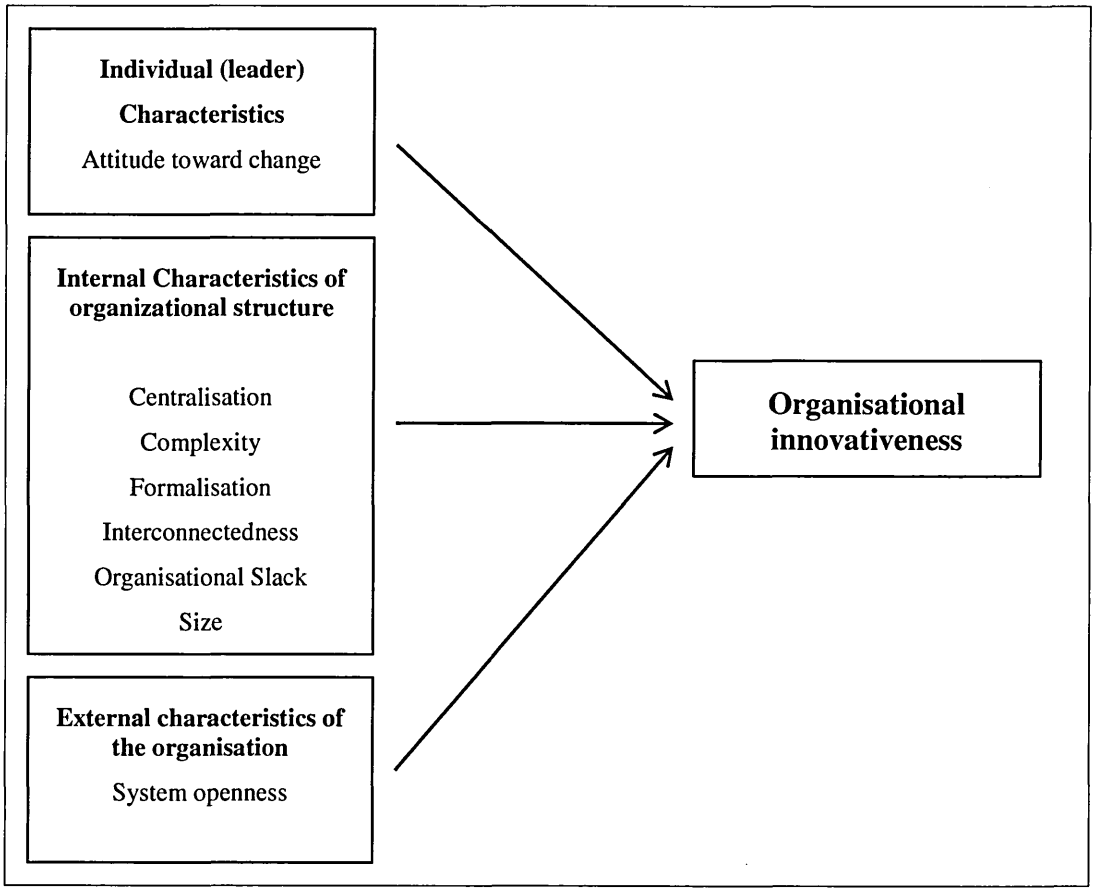

Figure 3.2: Diffusion of innovations (Rogers 1995)

The TOE framework was developed in 1990 (Tornatzky and Fleischer 1990). It identifies three aspects of an enterprise's context that influence the process by which it adopts and implements a technological innovation: technological context, organizational context, and environmental context (Figure 3.3). Technological context describes both the internal and external technologies relevant to the organisation. This includes current practices and equipment internal to the organisation (Starbuck 1976), as well as the set of available

technologies external to the organisation (Thompson 1967, Khandwalla 1970, Hage 1980). Organisational context refers to descriptive measures about the organisation such as scope, size, and managerial structure. Environmental context is the arena in which an organisation conducts its business—its industry, competitors, and dealings with the government (Tornatzky and Fleischer 1990).

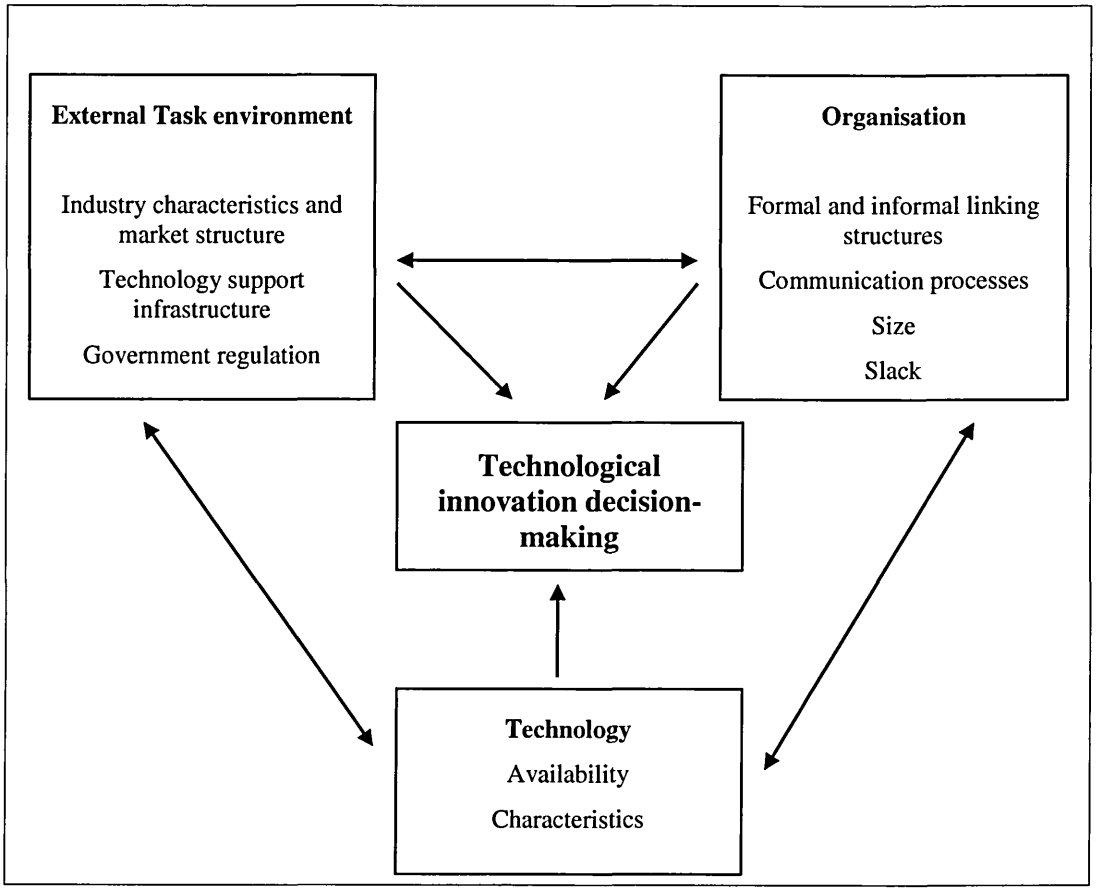

Figure 3.3 Technology, organization, and environment framework (Tornatzky and Fleischer 1990)

The TOE framework as originally presented, and later adapted in IT adoption studies, provides a useful analytical framework that can be used for studying the adoption and assimilation of different types of IT innovation. The TOE framework has a solid theoretical basis, consistent empirical support, and the potential of application to IS innovation domains, though specific factors identified within the three contexts may vary across different studies.

This framework is consistent with the DOI theory, in which Rogers (1995) emphasized individual characteristics, and both the internal and external characteristics of the organization, as drivers for organizational innovativeness. These are identical to the technology and organization context of the TOE framework, but the TOE framework also includes a new and important component, environment context. The environment context presents both constraints and opportunities for technological innovation. The TOE framework makes Rogers' innovation diffusion theory better able to explain intra- firm innovation diffusion (Hsu et al. 2006).

However, in order to develop a theoretically valid framework for exploring and explaining the adoption of OSS, it is necessary to consider factors that influence the adoption and usage of the innovation, which is rooted in the specific technological, organisational, and environmental contexts of an organisation (Fitzgerald 2009). Therefore, reviewing the literature suggests that the technology - organisation - environment (TOE) framework developed by (Tornatzky *et al.* 1990) is suitable to study contextual factors that influence OSS adoption in HEI.

The TOE framework, as described above, has been examined by a number of empirical studies on technology adoption in numerous ICT technologies including among others: (a) the adoption of electronic data interchange (EDI) (Iacovou *et al.* 1995), (b) open systems

adoption (Chau and Tam 1997), (c) e-business adoption(Zhu *et al.* 2004), and (d) e-CRM adoption (Racherla and Hu 2008). In the OSS context, Dedrick and West (2004) developed a TOE based model explaining the adoption of OSS server platform and tested it empirically. While some studies applied partial scope (Kuan and Chau 2001, Zhu 2006) other studies applied a more comprehensive scope (Chang *et al.* 2005, Hong and Zhu 2006, Raymond *et al.* 2005, (Xu *et al.* 2004, (Zhu and Kraemer 2005, Zhu *et al.* 2003) to the definitions of TOE components.

Some authors used the TOE framework along with other theories to understand IT adoption (Oliveira and Martins 2011). Studies combining the TOE framework and DOI theories include the following. (Thong 1999) joins CEO characteristics from DOI to the TOE framework. (Chong *et al.* 2009) add innovation attributes (relative advantage, compatibility, and complexity) from DOI and an additional new factor in the adoption study called information sharing culture characteristics to the TOE framework. (Zhu 2006) combined relative advantage, compatibility, cost, and security concern from DOI with the TOE framework. (Wang *et al.* 2010) add relative advantage, complexity, and compatibility from DOI to the TOE framework.

After reviewing its theoretical roots and empirical evidence, the author finds that the TOE framework has consistent empirical support, although specific measures identified within the three contexts may vary across different studies. Integrating this framework with the novel evaluation framework, the author proposes a conceptual model for OSS adoption for e-learning in HEI as illustrated in Fig (3.2). Drawing upon prior research combined with the review of factors of OSS adoption in HEI in section (2.1) to (2.4), the author believes that TOE framework is appropriate for explaining the adoption of OSS systems. The goal in this study was not to test a factor model of OSS deployment but rather to provide a rich description of the process of OSS adoption, with a focus more on theory development rather than theory testing.

Based on an extensive and rigorous review of the literature on e-learning adoption and open source adoption, the main reasons and factors that could explain the adoption of OSELA are identified as follows: (a) costs; (b) benefits; (c) barriers; (d) external pressures; (e) support; (f) the level of IT sophistication; (g) IT infrastructure and, (h) an evaluation framework that supports higher education institutes to assess OSELA. These factors were identified as occurring frequently in the literature, suggesting that they are likely to be relevant in the adoption of OSS by HEI. These factors are analysed below:

3.5.1 Costs

Higher Education institutes today are faced with financial pressures. With tight budgets and increased demand to enhance the quality of education, HE institutes find themselves often reluctant to proceed to a new investment prior to studying and analysing its total cost and expected benefits. E-learning promises to reduce institutional expenses and increase institutional revenues. Despite e-learning promises, some institutions may make a decision to abandon their plans for e-learning implementation and deployment, if they find that the cost associated with the adoption is beyond their budget, or if the cost is greater than the expected benefits. Even with the free Licence of open source applications, there is a cost associated with their implementation such as the costs of: training, maintenance, support, etc. (Fitzgerald and Kenny 2003, Waring and Maddocks 2005, Wang *et al.* 2010, Katz 2006) among others reported the influence of cost as factors in open source adoption. Thus, the author proposes that the cost associated with the deployment of open source e-learning applications in higher education institutes is considered to be influential factor for OSELA adoption.

3.5.2 Benefits

Benefits refer to the level of recognition of a relative advantage that OSELA can bring to the HE institute. Many research and case studies reported that HE institutions assess all types of benefits (e.g. financial, operational, managerial, and technical) that open source applications offer before deciding to adopt them (Machado and Thompson 2005, Khelifi *et al.* 2009, Sahraoui 2010). In the proposed model, benefits cover: (a) academic (enhance the

quality of learning), (b) financial (minimise the cost of integrating the technology in education and allow institution to run core business effectively), (c) operational (serves both administrative and academic needs efficiently), (d) technical (reduce the technical support crisis and shorten the distance between technologists and academic faculty).

3.5.3 Barriers

Open Source E-learning Application implementation is a complex project that depends on a clear vision from the strategic board, the interest and time of the project team, availability of funding and availability of resources. In order to avoid any potential draw back during implementation that could lead to failure on OSELA adoption, institutions have to estimate the possible impact of the adoption of OSELA before proceeding to its adoption. In this context, the author suggests that the barrier of OSELA is a factor that influenced its adoption in higher education institutes.

3.5.4 External pressures

Higher Education institutes are under pressure to provide best value for money services and have performance credibility within very strict budgetary boundaries. Moreover, the provision of technology to rapidly changing college and university communities is becoming a very acute task. The evolution and revolution of e-learning systems and the continuous digitisation of academic teaching and learning, research, processes and services in every institution put late adopters and laggards under the risk of losing their students. Therefore, colleges and universities are searching for new ways and practices to efficiently serve their administrative and academic needs. Thus, external pressure is proposed by the author to be an influential factor to the adoption of OSELA.

3.5.5 Support

Several studies have suggested that the availability of external support is an important factor that influences the decision to adopt OSS. Li, *et al.* (2005) observed the influence on the availability of external support on the intention to adopt OSS. In the same context,

Morgan and Finnegan noticed that the absence of external support may be an important barrier to the adoption of OSS (Morgan and Finnegan, 2007). Similarly, less reliable technical support available from third party vendors and/or the OSS community was considered to be a critical barrier to OSS adoption (Ven and Mannaert 2008, Goode 2005, Dedrick and West 2003). Despite the type of support chosen can differing from organisation to organisation, the ability to rely on external support has been found to provide some confidence and some reassurance to organisations (Morgan and Finnegan 2007, Fitzgerald and Kenny 2003, Waring and Maddocks 2005, Wang *et al.* 2010, Katz 2006). These findings suggest that access to external support outside the organisation has been found to influence its decision to adopt OSS.

3.5.6 The level of IT sophistication

This factor refers to the technical personnel available in the institution. It is related to the level of understanding of different kind of technologies, the ability to work with innovative solutions effectively, and the availability of skills (both technical and managerial) to address implementation problems at any institute. Moreover, the support delivered to the institute from external service providers is directly provided to internal technical users of the systems and tools. In this context, there is strong recognition of the adoption literature of technology skills of staff members as critical to open source software adoption (van Rooij, 2009). Thus the author proposes that the availability of IT human capital (knowledge, skill, abilities, and experience) within the organisation influences an organisation's decision to adopt OSS.

3.5.7 IT infrastructure

The existing IT infrastructure is a factor that affects the introduction of OSELA, as the needs of a flexible, manageable and maintainable integrated IT infrastructure is mandatory for the initiation of the process of adopting OSELA. In the same context, to ensure campus wide learning activities, the IT infrastructure should cover all learning and teaching areas.

3.5.8 The evaluation framework

The open source application market is developed regularly with many projects and products. The complexity of such a market comes from its diversity and large number of applications serving different type of organisations and solving different type of problems. The unavailability of a framework that supports Higher Education institutes in decision making to evaluate and select their applications makes it extremely difficult to choose to adopt OSELA. For that reason, a framework that support institutions in decision making for adopting OSELA can be considered as a factor that influences the adoption of OSELA.

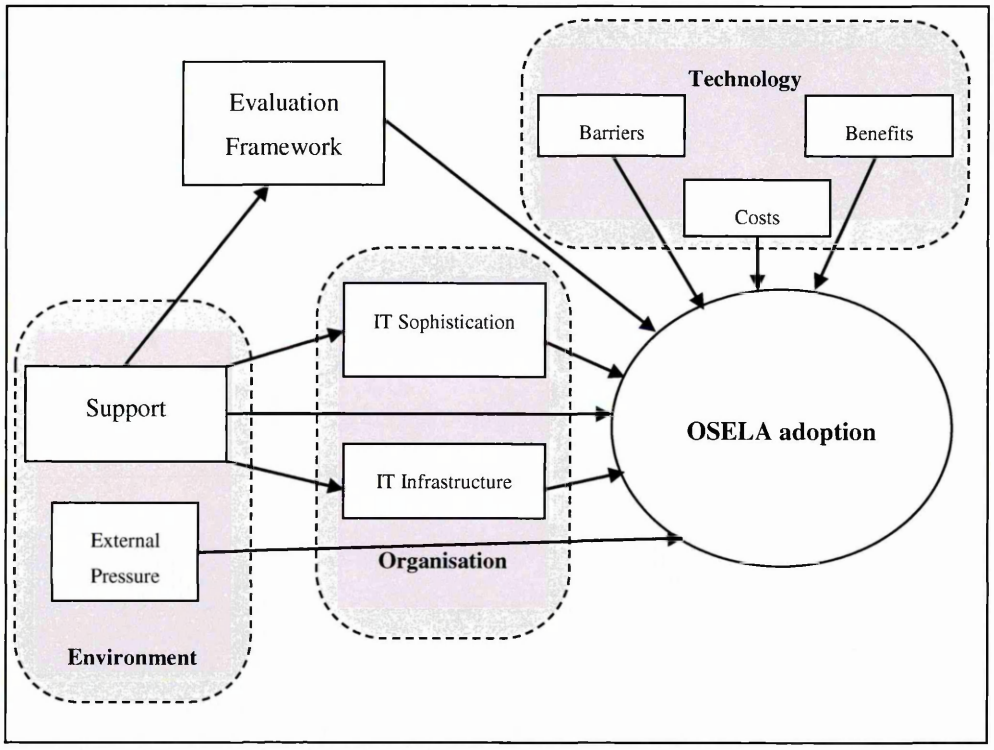

Figure 3.4 : The proposed Conceptual Model for OSELA Adoption in HEI based on TOE framework

The proposed model makes a novel contribution as it incorporates factors identified in previous studies as influencing adoption of open source software. The author expands these previous works and adapts them to the Higher Education sector through combining factors discussed in normative literature. Thus, resulting in the development of a consistent model,

which can be used as a frame of reference for the adoption of e-learning technologies in general (open source and proprietary) in the Higher education sector. In the same context, the proposed model introduces an evaluation framework as a factor that influences the adoption of OSELA. The evaluation framework clarifies the confusion surrounding the use of open source applications in higher education institutes and supports decision makers in evaluating and selecting their open source e-learning applications.

Chapter 4

Research Methodology

Chapter 4. RESEARCH METHODOLOGY

Chapter 4 discusses and describes the research methodology of the work presented in this dissertation. This description follows the research methods used in the Information Systems domain. In doing so, this research methodology takes into consideration the research problem stated in section (1.8). This chapter starts by section (4.1) that discusses and justifies the research foundation of this study by reviewing both positivism and interpretivism epistemological stances. This review results in the justification of the use of interpretivism as the research approach used in this dissertation. In section (4.2), the choice of qualitative research mode in this dissertation is explained and justified. Thereafter, the author justifies the adoption of case study research strategy. Section (4.3) discusses the design of case study, while section (4.4) discusses the data collection methods and the procedures applied in this field.

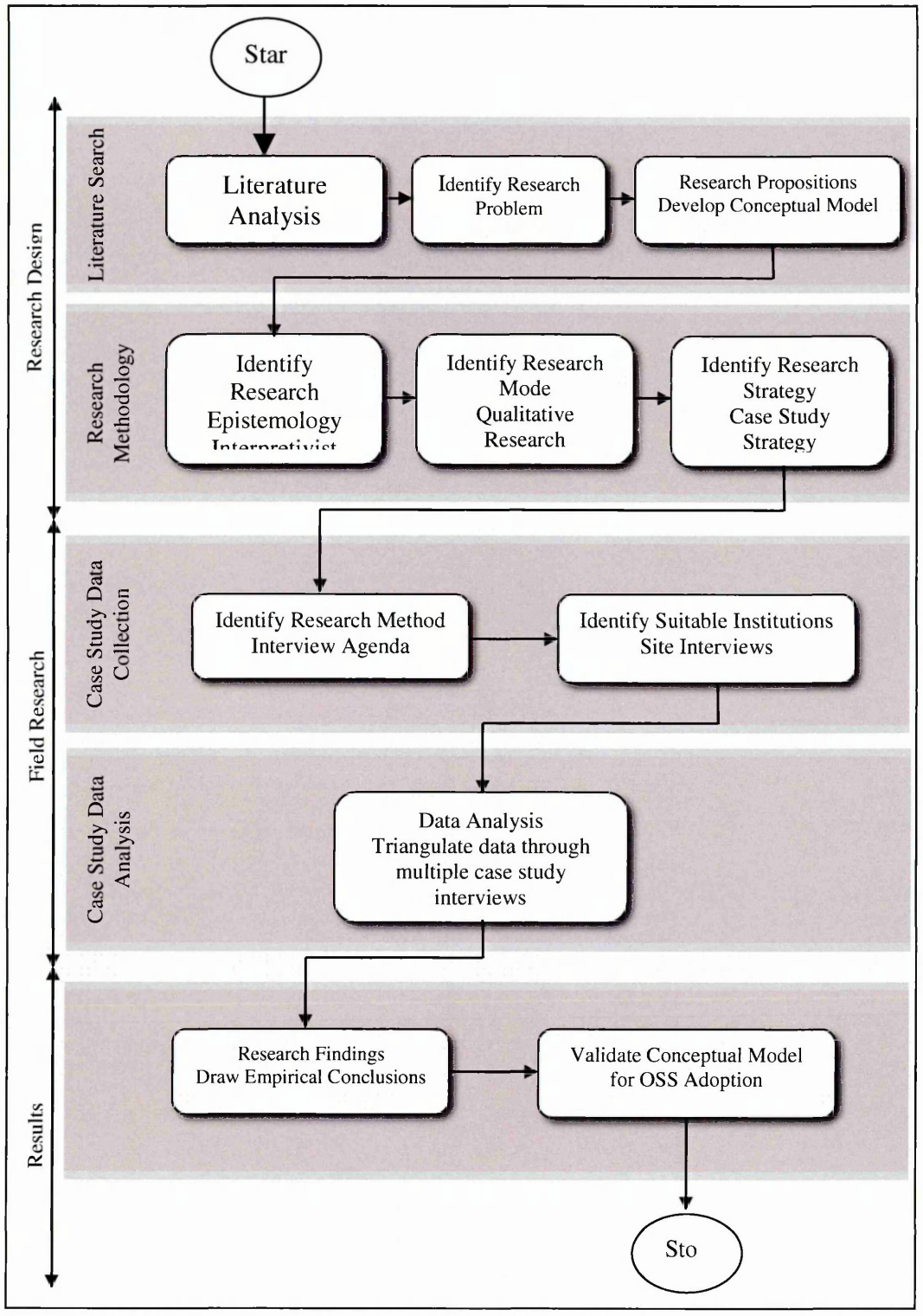

Figure 4.1: Empirical Research Methodology

4.1 SELECTING AN APPROPRIATE RESEARCH APPROACH

The selection of an appropriate research approach in the field of Information Systems (IS) is an important task in the research design process. However, Galliers (1992) amongst others argue that this selection is not an easy task. Since IS are related to many different sciences such as: social sciences, mathematics, and behavioural sciences. Thus, for its multi disciplinary nature, there is no single framework that can present all the domain of knowledge needed for IS study.

One of the elements available in the research paradigm is epistemology, which has been described as a form of representation of reality, related information sources and how to obtain it, possibilities of and limitations on knowledge of that reality (Mingers 2003, Sandelowski 2000, Klein and Myers 1999, Myers 1997). For IS research, there are many philosophical approaches such as: (a) positivism, (b) post positivism, (c) interpretivism and, (d) critical. These descriptions of epistemology, has often led the researchers in the IS field to choose interpretivism and positivism epistemological stances (Fitzgerald and Howcroft 1998, Miles and Huberman 1994, Yin 1994, Galliers 1992, Orlikowski and Baroudi 1991). Both positivism and interpretivism impact on empirical research study. Galliers (1992) indicate that positivism assumes that observations of the phenomena under investigation can be made objectively and rigorously, while interpretivism assumes that knowledge of reality is gained only through social constructions.

With regard to the phenomenon under investigation in this study, the presentation of the literature analysis in Chapter 3 and 4 identified many issues and factors related to the adoption of OSS in higher education. These factors were proved to be complex (includes many political, technical, managerial, and social issues) and subjective (related to organisational and cultural context). Thus, in order to better understand the phenomenon under investigation based on the research aim defined in section (1.8) interpretivist epistemology approach appears to be suitable because it accepts the complexity and subjectivity of the research phenomena (Sale *et al.* 2002, Fitzgerald and Howcroft 1998,

Myers 1997). Further justification of using interpretivism in relation to OSS complexity and subjectivity includes the following:

1. Knowledge on factors influencing OSS adoption need to be explored from their multiple natural settings. This is consistent with interpretivist approach which emphasises the realism of the contexts of the phenomenon (Sale *et al.* 2002, Myers 1997)
2. Knowledge on factors influencing OSS adoption need to be explored by capturing the subjective participants' experiences of OSS adoption. This is consistent with interpretivist approach which dictates that the researcher gains knowledge by participating in the subject of empirical study (Sale, *et al.*, 2002; Fitzgerald and Howcroft, 1998, Myres, 1997).
3. The area of OSS adoption study is still in its infancy (Aksulu *et al.* 2010, Bhadauria *et al.* 2009, Lakhan and Jhunjhunwala 2008). Therefore, exploring possibilities and limitations on knowledge of the factors is important to better understand the factors influencing OSS adoption. This is consistent with interpretivist approach which dictates that knowledge can be gained through an appreciation of possibilities and limitations of known or new concepts as they emerge from empirical observations (Galliers 1992, Yin 1994).

On the contrary, the positivist epistemology appears not to be valid to be adopted in this research as it assumes an objective view (Metcalfe 2005, Sale *et al.* 2002) and there are no hypotheses or quantifiable measures of variables or formal propositions in the research reported.

4.2 IDENTIFYING RESEARCH MODE

As discussed in the previous section on research paradigm, this researcher epistemology, which is an interpretivist stance, aims to explore, explain and understand factors, and why

and how they influence the adoption of OSS by HEI. This epistemology is consistent with a qualitative research mode because qualitative research modes also help to explain and understand complex and subjective contexts of a research phenomenon though interaction with their natural settings (Sale *et al.* 2002, Ivankova *et al.* 2006, Myers 1997).

On the other hand, literature in Chapter 3 suggests that there are gaps in knowledge due to the lack of explanatory theories on the adoption of OSS by HEI. This is also relates to many studies which suggest that OSS adoption research is still in its infancy (Fraser *et al.* 2006, Larsen *et al.* 2004, Dedrick and West 2003). This argument is supported by a suggestion made by Strauss and Corbin (1990) that qualitative research can be used to better understand any phenomenon about which little is known. In the same context, Hoepfl (1997) suggests that qualitative methods are appropriate in situations where one needs to first identify the variables that might later be tested quantitatively.

Qualitative research is described as a multi-method in focus, involving an interpretive, naturalistic approach to its subject matter (Creswell 2009, Denzin and Lincoln 1994). Miles and Huberman (1994) simply describe qualitative research as one that is based upon words rather than numbers. Qualitative research is more suitable in many types of research such as: (a) research which examines in depth into complexities and processes, (b) research on little known phenomenon or innovative systems, (c) research that sees to explore where and why policy and local knowledge and practice are at odds, and (d) research which relevant variables have not yet been identified (Marshall 1999).

On the contrary, a quantitative research mode is not suitable for exploring or explaining the complexity and subjectivity within this research phenomenon as it is more focused on predictions by measuring predefined variables or testing particular hypotheses across a stated population to achieve statistical generalisation (Hoepfl 1997, Ivankova *et al.* 2006, Myers 1997). Furthermore, quantitative research methods are unable to take into consideration the differences between people and the object of the natural sciences.

According to Benbasat *et al.* (1987) qualitative research approach have many benefits. These benefits supported the author's decision to choose a qualitative research method rather than quantitative research method for this study. The benefits and their relation to the research reported in this study include among others the following:

1. Qualitative research method allows the researcher to understand the nature and complexity of the process taking place. As described in the literature review chapter the issues under investigation are complex, subjective, and focus on human decision making which many are confidential and idiosyncratic. Thus, it is becoming clear that rich empirical data is required to better understand the human behaviour and the adoption process.
2. Qualitative research method allows the researcher to explore new emerging topics in the rapidly changing IS field. As discussed in Chapter 3, OSS research is still in its infancy and there are a very few studies on the adoption of OSS especially in HEI. Thus, qualitative research will support the author seeking to explore where and why policy and local knowledge and practices are at odds.
3. Qualitative research method allows the researcher to study IS in a natural settings, learn about the state of the art, and generate theories from practice. As described in previous chapters, this research cannot be carried out experimentally. Thus qualitative research will support the researcher to study OSS in its natural setting and learn from practice.

4.3 IDENTIFYING RESEARCH STRATEGY

In the previous sections, the researcher had identified and justified the use of interpretivism as an epistemological stance and the use of a qualitative research approach. This section will identify and justify the research strategy. There are many and different qualitative research strategies that have been reported in the literature such as: (a) action research, (b) ethnography, (c) grounded theory, and (d) case study. These strategies are described in the

next section in order to decide on the most suitable strategy that will shape the way in which data is collected and analysed in this research.

Action research strategy enables the researcher to observe and to make objective changes to the phenomenon under investigation (Avison and Myers 1995, Baskerville 1999). While ethnography enables the researcher to get immersed in the study phenomenon focused on people and culture (Myers 1999), grounded theory emphasises that theory emerges from the empirical observations and interpretations (Strauss and Corbin 1990, Rouse and Dick 1994), and the case study strategy is an intensive examination of a phenomenon that aims to investigate and understand a contemporary phenomenon within its natural context employing multiple methods of data to gather information from one or more entity (Yin 1994, Miles and Huberman 1994).

As stated in Chapters 2 and 3 OSS adoption research is a relatively new phenomenon, and research in this area is in its formative stage (Myers 1997), Aksulu *et al.* 2010, Bhadauria *et al.* 2009, Lakhan and Jhunjhunwala 2008, Larsen *et al.* 2004, Dedrick and West 2003). The given fact makes this IS research more appropriately investigated using the case study strategy with Fraser *et al.* (2006) suggesting that case study research is particularly appropriate for certain types of problems such as those in which research and theory are at their early formative stages. Moreover, based on this research question, aim and objectives stated in section (1.8) case study research is suitable for investigating OSS adoption phenomenon where boundaries between phenomenon and context are not clearly evident (Roethlisberger and Lombard 1977).

Miles and Huberman (1994), Eisenhardt (1989) and Yin (2003) suggest three different types of case study strategy, namely: explanatory, exploratory, and descriptive. The type of case study depends on the type of questions they are used to answering. Explanatory case study usually answer the WHY research questions, exploratory answer the WHAT research questions, and the descriptive case study answer the HOW research questions. As the

research question of this research as stated in section (1.80) is (what are the factors that influence the adoption of OSS in HEI?) the case study followed in this dissertation will be classified as exploratory case study. Exploratory case studies are useful for theory building as they are valuable in developing concepts for further study.

Thus, as the case study provides an appropriate research methodology to explore a situation in its natural setting, it allows the researcher to get a deeper understanding of the situation, and answer "why" questions that is very helpful in theory building research. The author considers the use of qualitative exploratory case study to be suitable for studying the phenomenon of OSS adoption in HEI.

4.4 EMPIRICAL RESEARCH METHODOLOGY

The research design is the first independent part of the empirical research methodology. The design starts by critically analysing the literature as shown in figure (5.1). The literature review results in identifying several research issues for a more focused literature review (OSS adoption in HEI). The research problem is then identified and research propositions are being developed. Thereafter, the development of a conceptual model is conducted and aspects of the model will be investigated through empirical studies. It was decided based on the need of the empirical study, to utilise a multi case study through the employment of qualitative research methods. Justification for the selection of qualitative research method was given in the previous section. Meanwhile, the following section will justify the selection of multi case study strategy.

4.4.1 Justification for multiple case study strategy

As discussed in the previous section, case study strategy is used for this study. Case studies, however, can be single or multiple cases. While single case provides rich primary data of the organisation, it does not provide sufficient data that would draw conclusions about OSS adoption and evaluation. Thus the author suggests that the use of multiple case studies will

allow the author to better examine and validate the findings. Moreover, the analysis of data across cases will be possible which will give the research a more robust investigation and findings.

By dismissing a single case study approach, the number of case studies conducted need to be determined. Miles and Huberman (1994) reported that the number of case studies depends on how much knowledge is available about the phenomenon under investigation and how much information can be uncovered from additional cases. However, some studies have limited multiple case studies used in a research strategy not to be less than four and not more than ten (Eisdenhardt, 1989) while others suggested that a multiple case study should not exceed five cases (Yin 2008). As such, the author will employ the use of multiple case studies within the limit suggested by Dyer and Wilkins (1991). A case sampling is applied to clarify the domain of this investigation on cases that are relevant to understanding OSS adoption for e-learning by HEI.

For the reasons discussed in Chapters 2 and 3, the author sets Egyptian Medical Schools as the boundary for sampling. Further sampling was applied to select cases that have adopted OSS in e-learning projects, mainly from the colleges already participating in the QAAP project, followed by a final sampling of cases that have potential for rich information. As a result, the research presented in this dissertation adopts a multiple case study strategy to study three Egyptian medical schools adoption of OSS.

4.4.2 Case Study protocol

The necessity of having a case study protocol was discussed by several researchers, with Gable (1994) describing it as a tool that would steer the research, act as an action plan, and set rules and regulations by which data would be gathered. The importance of the case study protocol is because: (a) it keeps the field work focused on the subject of the case study and the research methodology that was chosen (Gable 1994), and (b) it helps in predicting various problems before report writing. Thus, case study protocol acts like an

official document which the researcher uses to plan, schedule data gathering, specify different methods of data collection, and to describe the objective and procedures of analysis. Yin (1994) suggests four important elements for case study protocol namely: (a) overview of the study, (b) establishment of field procedures, (c) field questions, and (d) guide for case study. These elements are implemented in this study and are discussed in the following sections.

4.4.3 Case Study Overview

Case study overview includes project objectives and case study issues. This study's objectives were discussed in section (1.8) and the justification of qualitative research approach and the choice of multiple case studies were discussed early in this chapter. Therefore, the formal overview of the case study has been established. The author hereby indicates that the intention of this research is to describe case study perspective that allows others to relate their experiences to those reported. Thus, this study broadens the understanding of the phenomenon of open source software adoption for e-learning application in higher education.

4.4.4 Fieldwork procedures

The nature of case studies, that is related to the examination of a phenomenon in its natural real life setting, indicates that the researcher should take into consideration and manage 'real world' events such as respondents non appearing, documents not being available etc. Establishing fieldwork procedures gives a guideline for conducting field work and dealing with constraints that are associated with the process of data collection (Yin 2003). To deal with these constraints, a field work procedure for this research is developed as follows:

4.4.5 Gaining Access to key institutions

One of the most important issues is to specify who need to be interviewed. As adoption of new teaching and learning technologies in higher education requires the consensus of two

sub cultures namely the technologist and the academics (Yin 2003), many stakeholders need to be interviewed in all cases. Since OSS and e-learning are emerging technologies with multidimensional effects, there is often a fair distribution of knowledge among many players within many institution. The author considers three levels of stakeholders need to be interviewed namely: (a) Management level, (b) Pedagogical level, and (c) Technological level.

4.4.6 Identifying appropriate resources while in field

This issue deals with identifying suitable data gathering research methods and adequate resources to be used in field. Various resources including digital recording devices, tablet, notepad and pens, and logistics arrangements were organised before visiting case sites. Interviews were digitally recorded and transcribed at a later date. The digital recording proved it had better sound quality, recording editing functions and timing information than a tape recorder. To support the findings, additional documents, reports, archived documents were collected as shown in table (4.1).

4.4.7 Developing a procedure for assistance and guidance

Various methods including telephone conversations and email were applied to communicate potential problems to participants who could provide assistance, and also discuss constraints and give guidance.

4.4.8 Develop contingency plan

This issue was making allowances for unanticipated events, including changes in the availability of interviewees as well as changes in the conditions of the researcher. The scheduling of interviews was made flexible to accommodate changing situations with participants. In the case of the non availability of the interviewee at meeting time, predefined employees would take his position. These issues represent measures for dealing with issues that may constrain the progress of the field work.

C	Category	Respondent position	Type of Interview	Method of Interview
Case 1	Managerial	Dean	• Structured • Semi structured • Unstructured	• Face to face • e-mail • Phone • Official Meetings
		Vice dean for educational affairs	• Structured • Semi structured • Unstructured	• Face to face • e-mail
	Pedagogical	Head of Medical Education	• Structured • Semi structured • Unstructured	• Face to face • e-mail • Phone • Official Meetings
		Director of Unit of Quality in Education	• Structured • Semi structured • Unstructured	• Face to face • e-mail • Official Meetings
	Technical	Director of E-learning Unit	• Structured • Semi structured • Unstructured	• Face to face • e-mail • Phone • Official Meetings
		E-learning consultant	• Structured • Semi structured • Unstructured	• Face to face
Case 2	Managerial	Dean	• Structured	• Face to face
		Vice dean for educational affairs	• Structured •	• Face to face
	Pedagogical	Director of QAAP	• Structured • Semi structured • Unstructured	• Face to face • e-mail • Phone
	Technical	Head of E-learning Committee	• Structured • Semi structured • Unstructured	• Face to face • e-mail • Phone • Official Meetings
		E-learning consultant	• Structured • Semi structured • Unstructured	• Face to face
Case 3	Managerial	Dean	• Structured	• Face to face
		Vice dean for educational affairs	• Structured	• Face to face
	Pedagogical	Director of QAAP	• Structured • Semi structured	• Face to face • e-mail • Phone
	Technical	Head of E-learning Committee	• Structured • Semi structured	• Face to face • e-mail • Phone

Table 4.1: Data collection using interviews

4.4.9 Fieldwork questions

The third element of this case study protocol was to specify field questions which the researcher must keep in mind during data collection. Yin (2003) suggests that case studies need to consider important questions at five different levels. Level one is concerned with the questions asked of interviewees, which explore information regarding participants' reactions and feeling; changes in attitudes, perceptions or knowledge; and changes in skills. Level two is concerned with questions asked of an individual case study (see, research question in section 1.8) and provides an analytical view of OSS adoption within individual case organisations.

Level three is concerned with questions asked across multiple case enquiries, and provides a cross case view of OSS adoption by the participant. Level four is concerned with questions asked of this entire study and provides an answer to the research question, research aim and objectives (in section 1.8). Level five is concerned with questions asked that lead to research recommendations and conclusions beyond the scope of the study, which will be addressed during discussions about the research findings in Chapter 6 and conclusions drawing in Chapter 7.

4.4.10 Data Collection

The selection of data gathering tools is influenced by the types of information necessary to explore, explain and understand the research phenomenon (Lincoln 2002). The literature reports many data collection methods that could be employed in case studies. Eventually, the variety of qualitative data sources provides evidence from more than one source to support researcher's conclusion and findings. These sources of evidence include: (a) documents, (b) archival records, (c) interviews, (d) direct observation, (e) participant observation, and (f) physical artefact (Yin 1994 , Lincoln and Tierney 2004)

It is important to keep in mind that not all sources are relevant for all case studies (Eisenhardt 1989). Each case used in this research presented different opportunities for data collection. Given the fact that Case 1 is the environment where the author has been working for the last couple of years, documents were more accessible than the other two cases. In addition, the author was able to observe many findings from participating in the cases under investigation while this source of evidence was not possible in the other two cases. In the same context, all three cases did not have electronic archival records and the quality of the paper records was poor enough for the author to decide not to rely on them in this study.

The author in this research has used the qualitative data sources of evidence as presented in table (4.2). The following sub sections will describe the use of each source in this study.

Source of Evidence	Use of source in this research
Interviews	• Structured interviews • Semi- structured interviews • Unstructured interviews
Documents	• Reports from the institution under investigation • Data from official web site • Strategic e-learning plans • Deliverable of QAAP project on e-learning
Direct observation	• Formal and informal meetings with interviewees
Participant observation	• Participation in some implementation
Physical artefact	• Hardware and software

Table 4.2: Qualitative data sources and their use in this research

4.4.10.1 Interviews

Interviews are considered to be the main tool for qualitative research for data collection (Miles and Huberman 1994, Yin 1994, Stake 1995), and it was undertaken as an interactive

conversation with the participants which allows the researcher to pursue a guided and focused line of inquiry (Miles and Huberman 1994, Yin 2009). Interviews also allow researcher to go back and examine interpretations of some participants in some details. This is especially important as it reduces the risk of being totally dependent on key information.

In this study, interviews were the main data source in the three cases. People in each institution under investigation were interviewed using different types of interviews: structured, semi structured, and unstructured (Denzin and Lincoln 1994). The structured interviewees were based on the interview agenda presented in Appendix A. Given the fact that case study 1 is the environment where the author works, preliminary interviews were conducted within case 1 with staff members from the e-learning unit to validate the questions. No one had all the answers or deep knowledge of all investigated areas. Therefore the researcher had to reorganise the questions into 3 levels, namely: (a) managerial, (b) pedagogical and (c) technical. All participants in the study had different yet important roles during the decision making process for OSS e-learning adoption. For example, managerial stakeholders were more concerned with strategic and financial decisions, pedagogical staff was focusing on functionality and technical staff was interested in interoperability and integration possibilities. People were selected to cover three domains as shown in table (4.2). Structured and semi structured interviews usually took place in the interviewees offices and interview sessions were recorded in a bilingual conversation (English and Arabic) then transcripts were developed from the digital audio recording. However, unstructured interviews took place during lunches, coffee breaks and informal meetings. During these informal meetings, the researcher was able to collect important information and data regarding the case studies. The details of the different types of interviews conducted in the three cases are presented in table (4.3)

	Case 1	Case 2	Case 3
Managerial	• Dean • Vice dean for educational affairs	• Dean • Vice dean for educational affairs	• Dean • Vice dean for educational affairs
Pedagogical	• Head of Medical Education • Director of Unit of Quality in Education	• Director of QAAP	• Director of QAAP
Technical	• Director of E-learning Unit • E-learning consultant	• Head of E-learning Committee • e-learning consultant	• Director of E-learning unit

Table 4.3: Classification of interviews

In addition to the interview agenda, which is a series of questions related to the units of analysis and directed to different stakeholders (Appendix II), data was also collected through various sources such as: documents, records, meeting minutes, official reports, and the web site of the institutions. This multiple data collection method was essential to make triangulation possible and thus provide stronger substation of theory (Eisenhardt 1989).

4.4.10.2 Documents

Documents could be letters, memoranda, agendas, administrative documents, newspaper articles, or any document that is relevant to the investigation. In the interest of triangulation of evidence, the documents serve to support the evidence from other sources. Documents are also useful for making inferences about events. Documentation is favoured for being a stable source that can be reviewed repeatedly, has exact contents and broad coverage in a long span of time with many events and many settings (Miles and Huberman 1994, Yin 2003).

However, Miles and Huberman (1994) identified some weaknesses related to the use of documents such as: (a) possible low retrievability, (b) biased selectivity, (c) blocked accessibility, and (d) reporting bias of author. Documents can lead to false leads, in the hands of inexperienced researchers, which has been a criticism of case study research.

4.4.10.3 Direct observation

Direct observation occurs when a field visit is conducted during the case study. It could be as simple as casual data collection activities, or formal protocols to measure and record behaviours (Denzin *et al.* 1998). This technique is useful for providing additional information about the topic being studied as it covers events in real time and covers context of event. On the other hand, direct observation is proved to be: (a) time consuming, (b) selective as only some events will be observed, (c) reflexive as events may proceed differently because it is being observed and (d) costly as human observers per hour rate will produce extra cost on the researcher (Eisenhardt 1989).

The author was able during his numerous site visits to two of the cases to conduct the interviews to directly observe the implementation and the environment surrounding the deployment of different OSELA components. Moreover, these visits allowed the author to

meet with other stakeholders and to witness some events related to their roles in the project. These observations were supporting many findings from the interviews.

4.4.10.4 Participant observation

Same as direct observation; participant observation covers events in real time and covers context of event. Moreover, it is more insightful into interpersonal behaviour and motives and it makes the researcher into an active participant into the events being studied (Yin 1994). This technique provides some unusual opportunities for collecting data, but could face some major problems such as being biased to the investigator's manipulation of events. The researcher could alter the course of events as part of the group, which may not be helpful to the study.

As stated in section (4.4.10) the author has been working in Case 1 for the last couple of years. Being a member of the environment under study gave the author the opportunity to extract observations and findings through participating in many related events. During the past years, the author participated in workshops, seminars, sessions and group discussions with different stakeholder in Case 1. Moreover, access to participants and stakeholders was easier and more regular compared to Case Study 2 and Case Study 3.

4.4.10.5 Physical artefacts

Physical artefacts can be tools, instruments, or some other physical evidence that may be collected during the study as part of a field visit. Physical artefact is insightful into cultural features and technical operations (Yin, 1994). For this research, the author was granted limited access all three cases e-learning platforms. This access allowed the author to validate and triangulate findings from the interviews with a real life situation.

4.4.11 Data Analysis

Data analysis is the third part of the empirical research methodology presented in figure (4.1). Empirical data derived from case studies were triangulated and then empirical evidence was used to draw conclusions and resulted in the formulation of a model for OSS adoption in HEI. Another important issue that concerns interpretive researcher is research quality and rigor. The term that is usually related to these issues is that of triangulation as a means of validating results (Yin 1994). Various triangulation methods are discussed in the literature (Stake 1995, Yin 1994, Tellis 1997), with a suggestion of four types of triangulation namely: (a) data, (b) investigator, (c) theory, and (d) methodological. Janesick (2000) adding a fifth type called interdisciplinary triangulation.

Data triangulation means the use of variety of data sources in a study (Creswell and Miller 2000). The second type of triangulation is the investigator triangulation, which is the use of several different researchers or evaluators (Hoepfl 1997). According to Mayring (2007) theory triangulation refers to the use of multiple theoretical perspectives to interpret a single set of data. Methodological triangulation means the use of multiple methods to study a single problem. Finally, Interdisciplinary triangulation is related with the investigation of issues related with more that one disciplines (Janesick, 2000).

From these definitions, it can be concluded that data, methodological and interdisciplinary triangulation are being employed in this research and these results are summarised and illustrated in Table 4.4.

Organisation	Type of triangulation applied	Source
Case Study 1	Data	Reports Internet resources Newspaper Articles Interviews Deliverables Organisational records Observations
	Methodological	Documentation Archival records Interviews Observations Physical artefacts
	Interdisciplinary	Information Systems Management Culture Education
Case Study 2	Data	Reports Internet resources Interviews Observations
	Methodological	Documentation Archival records Interviews Observations Physical artefacts
	Interdisciplinary	Information Systems Management Culture Education
Case Study 3	Data	Reports Internet resources Interviews Organisational records
	Methodological	Documentation Archival records Interviews Observations Physical artefacts
	Interdisciplinary	Information Systems Management Culture Education

Table 4.4 Types of Triangulations used in this research

4.4.12 Research output format

Chapter 5 presents the empirical data analysis, and the format at which the output of the empirical inquiry will take. Thus, the conclusions drawn presents the factors identified from the cross case analysis, using the conceptual framework to explain the factors and their influence on OSS adoption in this study. The empirical factors are displayed within the conceptual framework and ultimately represented in a diagram as the adoption model of OSS e-learning applications by HIEs.

Chapter 5

Case Studies and Preliminary Research Findings

Chapter 5. CASE STUDIES AND PRELIMINARY RESEARCH FINDINGS

In this chapter the author examines the validity of the proposed conceptual model using the case study strategy. In doing so, the case of 3 medical colleges are presented and analysed in the following sections. Due to confidentiality reasons, the author uses the names *ALMEDCO, ALDENCO, and MAMEDCO* to refer to the organisations being reported.

As discussed in the previous chapter in section (4.6) interviews were conducted with different stakeholders. These stakeholders had an important role during the decision making process for Open Source E-Learning Applications adoption and evaluation as well as during the implementation of the e-learning project. Therefore, it was important to select a variety of roles in the e-learning project to obtain the views of stakeholders at different

levels in the institutions, namely in: (a) Managerial level, (b) Pedagogical (academic) level, and (c) Technical level. This variety supports better understanding of the phenomenon of OSELA adoption and evaluation.

Different interviews were conducted with Deans of the colleges and Vice Deans for education affairs from the higher board of management. From the academic level, interviews were held with head of Medical Education (ME) department and head of quality in education department. Finally, for the technical part, interviews were held with head of e-learning units (or committees) and IT managers. All participants in the study had different yet important roles during the decision making process for OSELA adoption. For example, managerial stakeholders were more concerned with strategic and financial decisions, pedagogical staff was focusing on functionality and technical staff was interested in interoperability and integration possibilities. All the interviews were digitally recorded and transcripts prepared after each individual interview.

Digital recording supported the author in collecting accurate data and interpreting them without time pressures. The availability of interviewees was a problem during the case studies, since they were too busy and therefore, there was limited time for interviews. Taking notes during interviews simply reduces the time of interviews, since notes' taking is time consuming. Thus, the author considered digital recording as a more effective way of conducting interviews. It also proved to have a better sound quality, recording editing functions and timing information than a tape recorder.

As discussed in Chapter two, the Quality Accreditation and Assurance Project (QAAP) is one of the recently implemented nationwide projects for higher education reform. The QAAP aims to enhance the quality of education. One of its main objectives is inducing new techniques and technologies to the curriculum and the management system of all participating colleges. It is through this project that funds are allocated to implement e-learning programmes in all participating colleges. It is worth mentioning that QAAP

operates on college level and not university level (Creswell and Miller 2000). Therefore, and as stated in previous chapter (4.3) all selected cases are participating in the QAAP project.

All colleges participating in the QAAP must enhance their educational systems within three years. They are provided with guidelines and standards for all main aspects of their educational system by the QAAP. The participating colleges receive funds proportional to the number of students and staff, and the nature of their studies. Thus, it is each college's sole decision to apply the reform through ways that are most suitable and adequate to its needs and requirements. The implementation of e-learning systems is mandatory set by QAAP, but it is up to the college to decide which tools to use, what type of systems to apply and in which area and programme to apply e-learning project.

5.1 CASE STUDY ONE – THE *ALMEDCO*

5.1.1 Background to the organisation

ALMEDCO is a public medical college that traditionally operates in the higher education sector. *ALMEDCO* consists of 3 academic campuses and nine university hospitals running for the clinical and medical research programmes. It has up to 7,200 students in the undergraduate studies, 3,500 in the postgraduate studies. The undergraduate studies consist of three main programmes namely: (a) the national programme, (b) the international programme, and (c) the French programme. The postgraduate studies offer three degrees – Diploma, Masters of Sciences, and Medical Doctorate- in 64 specialties. The college has 32 academic departments with around 1,800 full time academic staff. The Medical Education (ME) department is the department responsible for the development of education in the college, and the E-Learning Unit (ELU) works under the supervision and management of the medical education department.

5.1.2 Background to e-learning adoption drivers

During the last decade, e-learning has started to make way into developing countries and is believed to have huge potential for colleges struggling to enhance the quality of their education but still faced by scarce in resources. In Egypt, the inducting of technology into public universities was very slow. This delay conformed to Hoepfl (1997) five factors for the lack of major technological transformation in public universities, namely: (1) Complexity of the education systems, (2) fast changes in technology, (3) public education leaderships, (4) political influence of education; and (5) Slow changes in Education systems. On the other hand, transformation in the public sector needs too high level of investments, as well as a planned complex process of implementation to minimise the risks that might affect a very large number of students. The government has inaugurated many projects and initiatives through which most of the country's higher education public institutes have undergone extensive transformation in the way they operate. The overarching goals of these movements were to pave the way for e-learning to be used as a tool to overcome many problems and challenges caused by the existing educational system.

ALMEDCO believes that e-learning is required to maintain and expand its core educational activities. Such a tool will allow the college to easily adapt to its fast changing environment and gain competitive advantage *(Dean of ALMEDCO)*. *ALMEDCO* has recognised that the need for e-learning has been necessitated with the existing educational system causing numerous problems for the college. For instance, *ALMEDCO* could not support its goals of closer interaction between teachers and students or among students to work in collaborative learning activities due to the problem of large number of students faced by limited number of spaces *(Head of Medical Education)*. The main problems summarised from all interviews with *ALMEDCO* staff were caused by the existing traditional way of teaching *(App. 1)*. Main problems are presented below:

1. Large numbers of students to be taught simultaneously
2. Scarce of funding from government and no extra fees from students
3. Limited resources (class room, computer labs, Learning Centres, etc.)
4. Widespread geographical locations of students (students travel daily from places with poor and non-flexible methods of transportation).
5. Some females (especially coming from other governments that are conservative in nature) face cultural barriers (cannot travel alone, cannot stay late in the afternoon, come from suburbia)
6. Lack of suitable documentation of courses
7. Non availability of rich materials and books – books are printed in departments with low quality to be sold at affordable prices for students.

During the last couple of years, dramatic changes have been witnessed in the way learning is conducted in *ALMEDCO*. More staff are using the internet to prepare for their courses, deliver materials, and communicate with the students *(VD for Educational Affairs)*. On the other hand, students are using the internet to communicate with each other and with their professors, and to collaborate, find learning resources, and to sometimes learn from other colleges and learning communities *(Director of Quality in Education Unit)*. These two forces: students, who want to learn using different online channels and faculty, who use

different methods to deliver materials and use the internet to teach - enhanced the quality of learning. On one side, the spread of these activities pushed "anti technology" faculty staff that was reluctant in using the technology (the laggards), they were faced by demanding students. Similarly, the students who were anti-technology were forced to use it in order to keep track with their peers and teachers *(Head of Medical Education)*

Eventually, this accelerating use of technology from the other side put more pressure on College Management to officially deploy its formal online learning platform *(Director of Quality in Education Unit).* It was becoming clear that college management needed to have a more controllable and manageable process to control the quality of education delivered within both its premises and in online environment. In the same context, the implemented system needs to meet today's 'digital ready' students who have high expectations of what campus IT services should provide. The main challenge faced by *ALMEDCO* was that students usually benchmark colleges and universities' IT services with other public services free offerings (unlimited storage for e-mail, videos and files; social networking, accessibility to personalized contents and campus wide integration, etc.) putting more of a burden on the e-learning systems evaluation and selection criteria and procedures. **These findings report that internal pressure was one factor that yields to implementing e-learning.**

At national level, all interviewees from *ALMEDCO* staff confirmed that for the last decade, the Egyptian information technology society witnessed many improvements. These improvements derived for the culture of e-learning implementation in society in general and in *ALMEDCO* in particular. Furthermore, *ALMEDCO* conducted a survey to explore the readiness for e-learning implementation in the college. This survey was distributed both online and physically to all students and faculty members.The results of the survey showed many drivers for e-learning implementation. Those drivers are mentioned below:

1. The availability of Broadband Internet connectivity with prices decreasing notably, allowed many students and staff to use online libraries and allowed the access of large sized online multimedia materials necessary to better understand medical studies.
2. Increase of Government initiatives to enhance the infrastructure of information technology in Egypt.
3. Wide availability of cyber cafes nationwide increased the number of students using the internet.
4. Government projects to provide Personal Computers (PCs) to students and teachers with affordable price and easy installments increased the number of students and teachers owning PCs.
5. The success of "Tansik Online" initiative ("Tansik Online" is a governmental process that is conducted totally online. Every year, all 250 thousands students graduated from high school are mandatory applying for college admission by using a web-based system). This success increased the faculty, students and parents trust in the internet as a communication channel that can be used for official processes.
6. More educational software and simulations are available and used by different teachers.
7. Availability of sites with rich materials that enhanced the way medical students are learning and helped them to see, hear, and interact with different types of materials and subjects of their studies.
8. Staff is using the internet and electronic library intensively in their research.
9. Students are using the internet and especially social networks intensively in their daily life and are becoming more familiar with the technology.
10. Each year more usage of social networks among student groups to facilitate learning is increasing
11. Previous personal initiatives from staff to post their presentations online had very positive feedback. This type of "informal" e-learning existed among students and was started before the college deployed its official platform.

12. Many teachers are exposed in one way or another in e-learning while achieving their post graduate degree and their Continuous Medical Education (CME) credit hour courses.

5.1.3 Motivation to OSELA adoption

Recently, *ALMEDCO* realised the importance of inducing technology into education. From one point of view to overcome existing problems and from another to enhance the quality of education offered to students. At the same time, many learning styles proposed by Medical Education department were not feasible under the current circumstances (large number of students in lectures and clinics, scarce learning resources, bad quality of learning materials, etc.).

Initially, *ALMEDCO* had little knowledge on the complexity of adopting and implementing an e-learning system. The early attempts to use the internet for teaching were individual attempts with very simple methods. The scope of these attempts despite being limited to individuals and on departmental levels, provided a positive feedback from teachers and students. The main activity was to post materials on the internet for students to download and to print, these were mainly presentations that were conducted at lecture halls and text files. It was a one way communication without interactive activities.

The first *ALMEDCO* official large scale move to e-learning implementation was directed towards proprietary software. Moreover, *ALMEDCO* requested a proposal from a large multinational company to design and implement *ALMEDCO* e-learning portal. Due to the large number of potential users (around 13,000) the Licence fees were very high and far beyond the budget allocated by the college for e-learning implementation. *ALMEDCO* had to investigate the option of having the system designed and programmed by local software company to overcome the high prices. The decision to adopt home grown application faced major obstacles. These obstacles as summarised from all interviewees are listed below:

1. The expected length of time for the software development life cycle (Analysis, design, programming, testing, deployment, etc.).
2. Expected gap between the technologists (programmers) and the academics (instructors) hinder the functionality of the produced system.
3. Limited knowledge from both academics and technologists on the features needed to affect positively the learning strategies.
4. The immaturity of the produced system, as it would be first run and was not tested any where else beforehand.
5. Complexity of the deployment and the need for sophisticated IT and network infrastructure.

Recently and in the beginning of 2008, the college started seeking other possible solutions to overcome the emerging e-learning adoption barriers. An external consultant proposed implementing Open Source E-Learning Application. The proposed solution was Licence free (no money is paid for the software), well tested worldwide, and with a proven educational reputation (used in many universities and schools). Until this point, the decision to adopt e-learning system was financially based and driven by Information Technologists. In all discussions, very little attention was given to pedagogical needs and benefits; the alignment of software features with college's learning objectives and styles, the security of the system, and the accessibility of e-learning solutions. One major reason for that direction is related to limitation in financial resources. With a college official justifying this direction:

> *"Without the OSELA I do not think any college in the country will be able to implement e-learning programmes. Proprietary software works in Licence based system and is paid by number of users. The main problem of Egypt higher education system (and most of developing countries as well) is the large numbers of students and staff. The e-learning is seen as a cheaper and more flexible alternative to our traditional system. We cannot afford to implement*

any other application rather Open Source." (VD for Educational Affairs)

This indicates that the cost factors had influenced not only the decision to adopt OSELA but also the decision for introducing e-learning for all. For all subsequent stakeholders the term e-learning meant the OSELA used for the online environment. Furthermore, for the majority of users the e-learning was summarised in the use of the OS LMS, namely: MOODLE.

5.1.4 OSELA adoption process

ALMEDCO recognises that it is a huge challenge to select and choose the most appropriate e-learning platform as this is the first step to fully automate the institution and bring together all applications in an integrated learning environment that serves both academic and administrative needs *(Dean of ALMEDCO & VD for educational affairs).* Once the cost was the corner stone for the decision to use OSELA, the attention was directed on the process for the implementation of OSELA.

The direction of the faculty was clear in its strategic plan 2008-2011: "To reach an open system for learning and teaching. Learning should be student centric, activity based, and involve use of latest teaching technologies and methods. Teaching is providing the "Digital Campus" where students can learn anytime from anywhere."

At the beginning of the year 2008, fortunately, the systems environment was perfect for open source adoption as no other system – learning, administrative, financial, Human resources, or student information system - existed electronically. All the systems existed in paper forms. The common problem of integration of legacy system or migration from proprietary systems to open source were not valid in this case *(E-learning Consultant),*

therefore eliminating major barriers and obstacles that faced the diffusion of modern IT applications and systems.

An e-learning committee was formed to study and plan for the creation of an integrated e-learning environment using open source software. The committee members were chosen from the Medical Education Department, Faculty Administration, ICT Department and external e-learning consultant. The purpose of the committee was to explore available open source applications specifically developed and used for learning and teaching in higher education institutions. The exploration and evaluation were done both for managerial and pedagogical levels to meet the challenge of developing a standardised, homogeneous and integrated e-learning architecture. One of the most challenging issues was the absence of a standard framework to evaluate OSELA. Much research was conducted in this area but with different perspective and different views, mostly on Learning Management Systems (LMS) rather than the integrated learning environment. Therefore, the committee decided to prepare a study based on the availability and capabilities of existing OSELA.

The committee recognised 663 registered open source applications and projects specifically intended for the higher education sector. These OSELA were categorised into different categories to meet the *ALMEDCO* needs, such as: Learning Management Systems, Content Management Systems, Integrated Library Systems, Journal Open Systems, Students Information Systems, Financial Systems, Identity Management Systems, Social Learning Systems and Portals. The items in every category were shortlisted to the top three applications based on review from academic sites, rates, number of users worldwide, and maturity and stability of the application *(E-learning Consultant).*

However, *ALMEDCO* did not take the decision to adopt a fully integrated learning solution at that phase considering the following reasons *(Director of e-learning unit)*:

1. Risk of hidden high cost of implementation, and uncertainty of total cost of ownership
2. Poor ICT infrastructure
3. There is no single integrated OSELA that support the implementation of a global integrated learning environment
4. Limited knowledge on faculty and student response for the new teaching and learning method
5. Lack of e-learning knowledge among academic staff
6. Lack of technical knowledge among the technical staff
7. The absence of evaluation methodology or framework to support the institution to assess OSELA.

For all the above mentioned reasons, the committee recommended the implementation of a pilot OSELA adoption project. This indicated that barriers such as lack of technical knowledge, lack of evaluation framework, poor ICT infrastructure, insufficient information on Total Cost of the adoption, and level of e-learning maturity affected *ALMEDCO*'s decision regarding OSELA adoption.

5.1.5 Evaluation of OSELA

At the beginning of its e-learning implementation initiative, *ALMEDCO's* decision was totally technology driven. The richness of materials and availability of information the Internet offered, was the main driver implementing e-learning systems in *ALMEDCO (Head of Medical Education).* The question was how to successfully deploy e-learning systems rather than how to benefit from them to enhance the quality of education and what are the potentials and possibilities of e-learning in applying different learning approaches and techniques *(Director of Quality in Education Unit).* At a certain point, there were some requirements to have a different perspective for the implementation process that reflects the importance of improving the quality of education. Therefore, the e-learning committee aimed to identify the features required for enhancing the student learning experience in

higher education medical institute. Open source technology proved to be the perfect balance between technologists and academics. Though technologists did the development of the application, the review could be achieved by academics that identify their needs and requirements, and then local technologists could easily adhere to the code to apply specific needs or requirements.

5.1.6 Assessment of the proposed Evaluation Framework for OSELA adoption

The following sections describe the use of novel evaluation framework that was proposed in section (4.4) within the *ALMEDCO*. The multiple views from stakeholders involved directly in the evaluation and implementation of OSELA provide a great opportunity to assess the novel evaluation framework. In order to achieve this goal, interviewees were selected from all the stakeholders interviewed as stated in table (6.1) namely: (a) E-learning unit director, (b) Head of medical education, and (c) an external consultant.

The author asked the interviewees to indicate the importance of each evaluation criteria and then, to assess the selected applications using the three categories of evaluation criteria (Table 4.2). The evaluation follows the scale of ranking used by Miles and Huberman (1994) to assess the different applications. The ranking of applications follows a high (●), medium (◉), and low (○) scale of ranking. In addition to mark the applicability and non applicability, two symbols are used. The symbol (✓) indicates applicable, while the symbol (✗) indicates not applicable and the value (Grey shade) indicates that there is no available information regarding the issue under evaluation

Application Requirements	ELU Director	Head of ME	External Consultant (EC)
Maturity	●	●	●
Community	●	●	●
Longevity	◉	◉	◉
Licence	●	●	●
Support	●	●	●
Documentation	◉	◉	●
Security	●	●	●
Functionality	●	●	●
Interoperability	●	●	●
Customisability	◉	◉	◉
IT and Web profile	●	◉	●

Table 5-1: Importance of Application requirements at *ALMEDCO*

From the above table, it appears that interviewees have different perceptions relating to application requirements and issues. In interpreting the empirical data, it is clear that nearly all application requirements are considered to be of great importance. However, all interviewees said that customisation and longevity are of medium importance. A justification of rating the Customisation to be of medium importance came from E-Learning Unit director who stated that:

> *"Selecting a mature application leads to minimum* customisation, *thus it is more important to select a mature standard application with a strong community. In this case there wouldnot be a need to be*

highly customis*ed, however, some minimum* customisation *could be needed, and that's why* customisation *is considered to be of medium importance"*

When the interviewees were asked to justify the reasoning behind rating Longevity to be of medium importance, Head of Medical Education department answered:

"While it is important to select an application that has been for long time in the market and have had many versions, some new applications are more advanced in technology and fulfill emerging requirements. Moreover, nowadays more applications are emerging have learned from others mistakes and are introducing recent learning tools. That's why we found longevity to be of medium importance."

Interviewees did not share the same perceptions with regard to documentation and IT and web profile. The External Consultant viewed the documentation to be of high importance even if there are no plans to deeply alter the code from *ALMEDCO*. On the contrary, the head of ME and the ELU director indicated that due to the absence of talented staff which could alter the code and make changes to the application, the availability of documentation is of lower importance. Head of ME added:

"Generally speaking, if an institution succeeds to get a mature application, with strong community and a very responsive support, and at the same time functional and interoperable, I believe minimum development will be needed, that's why documentation will not be of high importance"

Finally, IT and web profiles are reported by both external consultant and the ELU director to be of high importance, while the head of ME considered it to be of medium importance. The three interviewees were then asked to evaluate the OS applications using the three categories of evaluation criteria (Table 3.2). Table (5.2) summarises the interviewees' perceptions related to OSELA.

		Application Purpose								
		Industrial Focused			Education Focused			General		
		ELU	ME	EC	ELU	ME	EC	ELU	ME	EC
Learning	Learning management system	×	×	×	●	●	●	×	×	×
	e-Library Systems	×	×	×	●	●	●	×	×	×
	Social Learning Systems	○	○	○	◉	●	◉	✓	✓	✓
	Portfolio Management Systems	◉	○	○	◉	●	●	✓	✓	✓
Supportive	Research Administration	×	×	×	●	●	●	×	×	×
	Conferences Management	×	×	×	◉	●	●	×	×	×
	Journal Administration Systems	×	×	×	●	●	●	×	×	×
	Portal Administration Systems							●	●	●
	Office Productivity							○	○	○
	Web Browsers							●	◉	●
Business	Student Information System	×	×	×	●	●	●	×	×	×
	Facility and Class Management	○	×	×	●	●	●	○	◉	○
	Financial Management	◉	○	○	◉	◉	●	◉	◉	◉
	Human Resources Management	◉	○	○	◉	◉	◉	◉	◉	◉
Infrastructure	Operating Systems							●	●	●
	Identity Management System							●	◉	●
	Web Servers							●	●	●
	Database Servers							●	●	●
	Unified Communication Systems							●	●	●

Table 5.2: *ALMEDCO* evaluating OSELA using application purpose

5.1.6.1 Application Purpose category

Interviewees reported that due to the special characteristics of higher education systems, it was difficult to find proprietary software that totally fit HE requirements on all the four levels of OSELA. The OSS gave more choice of applications that were written specifically for the academic environment. The use of such applications proved to save time and money for *ALMEDCO* as they were designed to fulfill specific higher education requirements.

As reported in Table (5.2) almost all the interviewees indicated that the applications contained in the category of learning application should be educationally focused. Those applications deal with the unique characteristics of the education industry, that is why they should be written and directed to academia. Meanwhile, interviewees indicated that it is still applicable to use social learning systems and portfolio management systems designed for general purpose if they are proved to be a better fit for higher education requirements, than that of other systems that are educational focused. On the contrary, they believe that it is not applicable to find learning systems that are general or industrial focused.

With regard to supportive services, initially all three interviewees indicated that separation should exist between office productivity and web browser. When the external consultant was asked to comment on this suggestion, he answered:

> *"The choice of office productivity systems will not affect the user performance on using and accessing OSELA as almost all of LMSs are compatible with different types of file. In the contrary, the use of OS web browser has a great effect on the way that data are accessed and viewed from the e-learning platform. The selection of proprietary software may in many cases* minimise *the options and features available to users especially to educators who wish to edit and contribute to a web page."*

Thus, since there is practical evidence that proprietary browsers limit the functionality available in the OSELA, the author took this suggestion into consideration and separated the office productivity system from the web browser, to enable different analysis from interviewees.

With regard to supportive applications, interviewees found research administration, conference management and journal administration to be of high importance specifically in post graduate and research studies. *ALMEDCO* organise around sixty annual conferences for all its specialties. As a result, accessibility to all of its conference procedures is becoming essential. Those applications are very likely written by academics and directed only to higher education domain. On the other hand, the rest of supportive applications (portal admin, office productivity and web browsers) are more likely to be general applications that are used in the higher education domain. For the office productivity systems, interviewees did not have enough information to decide the importance of having OS office productivity system rather than having the dominating proprietary office system.

While both learning and supportive categories had applications directed mainly at the academic environment, the business category is still lagging behind with a few number of applications that are educational focused. Interviewees reported some areas (like Financial Management and Human Resources Management) was not supported by applications that take into consideration the special requirements of higher education domain. The general applications needed a high level of customisation and increased the need to use talented developers, which was time consuming and a financial burden to *ALMEDCO*. On the other hand, applications were developed for similar industries (i.e. Training centres, elementary education) were easier to adapt.

Finally with regard to infrastructure, all interviewees found them to be general systems that are very important to a successful OSELA deployment, with ELU director explaining:

> *"The use of open source infrastructure solved many problems that we faced in the beginning while using proprietary software. Although most of the open source applications that we are using are flexible and run on a multiple profile of servers, operating systems and databases, when those applications are installed on open source infrastructure the problems tend to be less and the performance increased noticeably."*

5.1.6.2 E-learning mode category

Thereafter, interviewees were asked to assess OSELA using the e-learning mode category. Table (5.3) represents the evaluation results. Table (5.3) shows the assessment of OSELA by interviewees using the e-learning modes as evaluation criteria. Based on their answers it appears that the infrastructure level supports all three types of e-learning mode. Similarly, LMSs and e-library systems are mostly important for all three types. On the contrary, all interviews reported Office productivity to be low important, and the facility management systems are not applicable in the online blended and self based e-learning modes. When the ELU director was asked to explain she said:

> *"The online blended and self based e-learning modes are totally online without having to attend any classes. Thus the use of facility management systems will be of waist as there are no physical facilities to mange. However, the online blended modes might have classes that encompass many students and tutors to be available synchronously. This is solved through course module available in mostly all the OSLMSs."*

		e-learning mode								
		Blended e-learning			Online Blended e-learning			Self Based e- Learning		
		ELU	ME	EC	ELU	ME	EC	ELU	ME	EC
Learning	Learning management system	●	●	●	●	●	●	●	●	●
	e-Library Systems	◉	●	◉	●	●	●	◉	●	●
	Social Learning Systems	○	◉	●	●	●	●	○	◉	○
	Portfolio Management Systems	●	●	●	◉	○	◉			
Supportive	Research Administration	◉	◉	◉	◉	◉	●	◉	●	●
	Conferences Management	◉	○	◉	◉	◉	◉	◉	◉	●
	Journal Administration Systems	◉	◉	◉	◉	◉	●	◉	◉	●
	Portal Administration Systems	●	◉	●	●	◉	●	◉	◉	●
	Office Productivity	○	○	○	○	○	○	○	○	○
	Web Browsers	●	◉	●	●	◉	●	●	◉	●
Business	Student Information System	●	●	●	◉	●	●	◉	◉	◉
	Facility and Class Management	●	●	●	×	×	×	×	×	×
	Financial Management	◉	●	◉	●	●	●	●	●	●
	Human Resources Management	◉	◉	◉	◉	◉	◉	○	○	×
Infrastructure	Operating Systems	●	●	●	●	●	●	●	●	●
	Identity Management System	●	●	●	●	●	●	●	●	●
	Web Servers	●	●	●	●	●	●	●	●	●
	Database Servers	●	●	●	●	●	●	●	●	●
	Unified Communication Systems	●	◉	●	●	◉	●	◉	◉	○

Table 5.3: *ALMEDCO* evaluating OSELA using e-learning mode

Clearly, from the previous results summarised in both table (5.2) and (5.3) it appears that the office productivity systems are of limited importance to be evaluated within required systems to be available in the OSELA. The author takes into consideration their elimination from the evaluation framework. After the assessment, interviewees expressed their satisfaction regarding the use of the proposed evaluation framework. They found it helpful in evaluating different available applications, eliminated much of the confusion surrounding the use of OSS for e-learning purposes, and most of all gave them the chance to decide what applications must be incorporated in their integrated e-learning environment. They have also emphasised on the influence of the framework on decisions for OSELA adoption. The following table (5.4) summarises all answers from ALMEDCO interviewees.

		Application Purpose									e-learning mode								
		Industrial Focused			Education Focused			General			Blended e-learning			Online Blended e-learning			Self Based e- Learning		
		ELU	ME	EC	ELU	ME	EC	ELU	ME	EC	ELU	ME	EC	ELU	ME	EC	ELU	ME	EC
Learning	Learning management system	×	×	×	●	●	●	×	×	×	●	●	●	●	●	●	●	●	●
	e-Library Systems	×	×	×	●	●	●	×	×	×	⦿	●	⦿	●	●	●	⦿	●	●
	Social Learning Systems	○	○	○	⦿	●	⦿	✓	✓	✓	○	⦿	●	●	●	●	○	⦿	○
	Portfolio Management Systems	⦿	○	○	⦿	●	●	✓	✓	✓	●	●	●	⦿	○	⦿			
Supportive	Research Administration	×	×	×	●	●	●	×	×	×	⦿	⦿	⦿	⦿	⦿	●	⦿	●	●
	Conferences Management	×	×	×	⦿	●	●	×	×	×	⦿	○	⦿	⦿	⦿	⦿	⦿	⦿	●
	Journal Administration Systems	×	×	×	●	●	●	×	×	×	⦿	⦿	⦿	⦿	⦿	●	⦿	⦿	●
	Portal Administration Systems							●	●	●	●	⦿	●	●	⦿	●	⦿	⦿	●
	Office Productivity							○	○	○	○	○	○	○	○	○	○	○	○
	Web Browsers							●	⦿	●	●	⦿	●	●	⦿	●	●	⦿	●
Business	Student Information System	×	×	×	●	●	●	×	×	×	●	●	●	⦿	●	●	⦿	⦿	⦿
	Facility and Class Management	○	×	×	●	●	●	○	⦿	○	●	●	●	×	×	×	×	×	×
	Financial Management	⦿	○	○	⦿	⦿	●	⦿	⦿	⦿	⦿	●	⦿	●	●	●	●	●	●
	Human Resources Management	⦿	○	○	⦿	⦿	⦿	⦿	⦿	⦿	⦿	⦿	⦿	⦿	⦿	⦿	○	○	×
Infrastructure	Operating Systems							●	●	●	●	●	●	●	●	●	●	●	●
	Identity Management System							●	⦿	●	●	●	●	●	●	●	●	●	●
	Web Servers							●	●	●	●	●	●	●	●	●	●	●	●
	Database Servers							●	●	●	●	●	●	●	●	●	●	●	●
	Unified Communication Systems							●	●	●	●	⦿	●	●	⦿	●	⦿	⦿	○

Table 5.4: *ALMEDCO* evaluating OSELA using Application purpose and e-learning mode

5.1.7 Pilot of OSELA Adoption

The pilot project consisted of deploying five open source applications namely: (a) the Learning Management System, (b) Journal Management System, (c) Communication System, (d) Portal Management System, and (e) Surveying System. These applications were installed in the cloud on a dedicated server. As per agreement with the cloud computing provider, the operating server systems, the web server and the database server were all OSS. This decision was taken by the e-learning committee after a recommendation from the IT department and strong support from the e-learning committee member. The process and justification for the selection of those systems in particular are summarised by all the interviewees in the coming section.

The LMS was the essential application in the intended campus wide OSELA, as it contains all features that are affecting directly the learning process. It is considered to be the place where students will spend much of their online time, where the interaction between students and their professors will occur, and the place where e-learning will take place. Therefore, a very comprehensive and functional comparison was conducted within the e-learning committee member and different open source LMSs. The evaluation was based mainly on the availability of learning tools, the widespread use of the LMS in other universities in Egypt in specific and worldwide in general, and the features that distinguish the LMS from other competitors. The committee has started the evaluation process by assigning different members for each selected LMS. The task of the members is to search the internet for product features, reviews, and published case studies. Thereafter, a group discussion was held to conduct the comparison based on members' findings. Finally, the decision was taken to select the most suitable LMS.

After the decision was made to adopt a specific LMS, the same procedures followed in selecting the journal management system. The need to implement a Journal management system at the early stage of OSELA implementation was due to some obligation on the college administration to automate its fifty year old journal. All old documents were

digitised and uploaded to the system that allowed all *ALMEDCO* student, teachers and researcher to access them. After the system was deployed and optimised, the next journal issue used the automated system in the all journal publishing cycle (i.e. submission, forwarding to reviewers, accepting, and publishing were done entirely online).

In the same context, the e-learning committee assigned the selection of suitable portal management and communication systems to the IT department. While the portal aimed to be central to all applications that are residing in the OSELA, the communication systems had two main objectives. First, it was the official way to correspond within the ALMEDO premises, not only in the learning process but also in managerial and administrative correspondences. Second, it was used as an authentication method to allow users within *ALMEDCO* to access their own specific areas of activities.

Finally, the decision to deploy an online survey system in the early phases on e-learning implementation was taken to solve a major problem. Each term, the quality unit had to conduct a final evaluation survey among all 11,000 students located in 4 geographically separated campuses. The amount of surveys, cost of papers, fees for surveyors, and difficulty in locating students made this task a burden. Therefore, the response rate of the students was very low, the quality of answers was very poor and the analysis time was very long. Thus, the Open source survey system allowed e-mailing surveys to students e-mail and offered a real time online analysis. The selection of the survey system was also assigned to the IT department.

Following successful implementation, a survey gathered feedbacks from all stakeholders (teachers, students, technical staff, administration and the faculty management board). The survey was a very useful tool for extracting important data. Together with direct observations from the E-learning adoption committee members, the institution was able to evaluate the efficiency and risks of the pilot project, identified benefits, barriers, and costs related to the adoption and thus move to the adoption of an integrated OSELA *(Director of*

Quality in Education Unit). Moreover, the management board decided that the E-learning unit should be responsible for the deployment of future applications and to maintain the e-learning platform.

At that point, interviewees reported that the availability of a framework to evaluate different types of OSS available for e-learning could have offered better analytical tool to the committee. It could have saved time and resources, and most importantly, it would have better guided the committee on what to look for while taking the decision to adopt new OSS application.

5.1.8 Benefits

The author asked the interviewees to determine the benefits from the implementation of OSLMS. All interviewees agree with ELU director who reported that:

> *"Although there is a difference between the implementation of few applications and the implementation of a total integrated e-learning environment, eventually, it is expected that the integration between different applications will add value to the platform, we do not expect that benefits will be of great differences."*

The interviewees' answers regarding the expected benefits from the adoption of OSELA found to be in line with the model proposed by (Machado, 2005) (see section 3.5). It appears that interviewees share common perceptions regarding OSELA benefits. The main findings include:

Economically: The e-learning term by itself is still in its infancy. With many debates around the method of implementation and the real benefit of e-learning in teaching and learning improvement is still in the research (see Chapter 2). The resistance of

change among students and staff expand the time needed for implementation producing extra costs. This cost would have increased if proprietary software was to be chosen. More than one year was needed until the issue of using e-learning in education was resolved, teachers were trained, e-courses were structured, and students were able to use the system. The use of OSELA gave the administration and the management board of *ALMEDCO* the opportunity to expand the knowledge around e-learning and its benefits without being under stress of payments and extra costs.

Philosophically: the open source movements are rooted in the constructivist movement. The constructivist movement itself is rooted in pragmatism and instrumentalism that pervades theories of understanding as applied to learning (Creswell and Miller 2000). This alignment made it very easy and useful to use OSELA by the teachers and lectures.

Technically: The choice of OSELA - though it is financially based - has proved successful. Every emerging need for application is facilitated by simply downloading and installing the appropriate software. The trialability of OSS made real life testing and assessment possible resulting in a better judgment and decision making process. Moreover, as all applications follow the Global Public Licence (GPL) it is easy to integrate all types of applications together to benefit from shared services *(Director of e-learning unit, e-learning consultant).*

Pedagogically: Though most of e-learning applications were written from a technologist perspective rather than pedagogical perspective, the OSELA succeeded in providing a modular and multilingual platform that could be easily accessed by all students and teachers. The use of OSLMS proved to be a good match between tutors needs and what technologists offer.

5.1.9 Barriers

The interviewees were then asked to identify the barriers of using open source software. Their answers were summarised as follows:

1. There is a need for talented e-learning people. The market is loaded with web administrators and programmers, but very few are available in the area of effective use of technology in education. There is a need for Educational Technologist, Instructional Designers and e-learning specialists.
2. In the same context, commercial vendors have many third party centres that provide support, training, and troubleshooting. A similar scheme is not available with Open Source. The whole movement depends on individuals not enterprises, increasing the risk of discontinuity of the project by the unavailability of persons.
3. There is no support in the local community for Open Source, minimising the potential of moving from one provider to another.
4. The lack of knowledge of the e-learning concept, methodology, strategy and benefit among staff members form a barrier for any implementation initiative (either proprietary or open source). Many faculty members look at the new system as a replacement to the traditional one and not as an addition to it.
5. Faculty staff members are looking to Open Source as an experimental movement and as non-mature software that still need testing, while others think that as it is for free it lacks a lot of features that are only provided in paid software.
6. The risk of not getting a response from the communities for troubleshooting (lack of warranty and committed support).
7. It is not permitted to use certain types of data and records (student registration system and test banks) in the cloud computing environment *(VD for Educational Affairs)*. This type of data must be stored locally and not integrated with the online LMS. The lack of this integration between student records and the LMS duplicate certain tasks and could results in redundancy in databases.

5.1.10 Costs

At the beginning, the factor that favoured OSELA over the proprietary software was the cost of its implementation. For many organisations, the term "free" was misleading. The management interpretation of the term "free" was with no cost at all. Though this is partially true with regard to the fees that should be paid for the Licences, costs would still be incurred for implementation, support, maintenance and training. The term "free" means freedom to alter the code, reuse the software without permission and redistribute it.

However, *ALMEDCO* noticed that even with the hidden costs associated with OSELA implementation, this implementation is not totally without cost, the cost of OSELA implementation was very low in comparison with the offered proprietary software. When the interviewees were asked to identify the costs of OSELA adoption at *ALMEDCO*, they were not able to answer some due to confidentiality reasons and others due to non-availability of real and exact figures. However the external consultant had estimated the total cost to be around two hundred thousand Egyptian Pounds.

The cost of implementation was divided into two parts: direct and indirect costs. The direct cost included the amount of money that had to be paid against the performance of certain activities such as: hardware, web hosting, maintenance, support and consultancy. On the other hand the indirect cost was divided into two categories: indirect human costs and indirect organisational costs. The indirect human costs include new employee salaries, employee training, and employee motivation and management compensation. The indirect organisational costs included managing resistance of change, reorganisation of the curriculum, restructuring of the organisation and business process reengineering.

Table (5.5) classifies the costs of OSELA adoption at *ALMEDCO* based on its importance by summarising all responses from interviewees.

Category		Cost Item	Description	Value
Direct Cost	Technology Costs	Initial Licence	Purchasing price	*Not available*
		Annual Licence	Renewal fees	*Not available*
		Maintenance	Staff time	Low
		Upgrade	New version price	*Not available*
		Hardware Costs	Cloud computing	Low
		Web hosting Costs	Cloud computing	Low
Indirect Cost	Human Costs	Support	Staff Time	Low
		Integration & Interoperation	Easily modified by staff, shared from other institutes	Medium
		Customisation & Localisation	Easily modified by staff	Low
		Consultancy Costs	External Consultancy	**High**
		IT employee salaries	IT staff with OSS related skills	Medium
		Academic Staff training	Training on using the application	Low
	Organisation Costs	Managing resistance of change	Seminars, workshops, group discussions	Medium
		Reorganisation of the curriculum	Staff and academic consultant time	Medium
		Restructuring of the organisation	Consultancy and staff time	Medium
		Business process reengineering	3rd party and consultancy	**High**

Table 5.5: Classification of *ALMEDCO*'s OSELA adoption costs

As it is summarised in the table above, it is reported that consultancy, reorganisation of the curriculum and business process reengineering were the highest cost during implementation. Managing the resistance of change and restricting the organisation as well as the indirect human costs were reported as costs of medium importance. Maintenance and support as well as web hosting and hardware costs are characterised as costs of low importance.

5.1.11 Support

The availability of support through the open source community has been approved as a strong point for OSELA adoption in *ALMEDCO*. When asked for the reasons, the director of ELU explained:

"The community involved thousands of participant and many channels of communication. It is not just a source for support, but also for learning and innovation. Each time we faced a problem we went first to search in the archived databases and learning from other mistakes. It was rare that we did not find a similar problem with a perfect solution, however a couple of time we had to post our problem in the forum for discussion. Amazingly, we had tens of responses each one proposing a solution and finally we had our issue resolved within no more than 36 hours. This action is even far better to call support from the local market; it would usually take more than that time for issues to be resolved."

5.1.12 External Pressure

For many decades, *ALMEDCO* was operating in a non-competitive environment. *ALMEDCO* had a large demand, and students on the undergraduate programmes were admitted through the ministry admission system. For post graduate studies, the demand was still high and mostly from the same students who graduated from the undergraduate programme.

However, after applying the international programme, suddenly *ALMEDCO* found themselves competing with the whole world to attract students. Moreover, with other medical schools in the country offering studies for international students, the pressure increased on *ALMEDCO* to provide competitive high quality learning experiences *(Dean of ALMEDCO and VD for educational affairs).*

Furthermore, for postgraduate studies, e-learning made it possible for local students to apply to international institutes and learn while they are based locally. Following this case, students who are mostly full time employees preferred to study at their ease on a flexible time frame instead of being obliged to attend lectures at unsuitable times.

Finally, many other medical colleges also applied also for the QAAP project, which created a competitive environment between colleges. The success of certain colleges will put more pressure on *ALMEDCO* not to fail. Moreover, the application for the QAAP project indicated periodical audit and assessment from the QAAP board and a time limit to accomplish QAAP goals within three years. The external pressure on *ALMEDCO* to adopt and implement OSELA can be summarised in the following:

1. Local medical colleges participating in QAAP project.
2. Local medical colleges offering e-learning programmes.
3. International medical colleges offering online postgraduate studies to local students.
4. Time limit to implement e-learning programmes and the audit and assessment from the QAAP board of directors.

5.1.13 IT Sophistication

Interviewees have all agreed that the availability of talented IT staff is one of the major challenges in public colleges. Due to financial reasons, it is not possible to employ full time highly skilled IT staff. However, the moderate use of OSELA proved it did not need a highly technical staff. On the contrary, a good system user and implementer could easily deploy the system and easily communicate with the support and OS community. The external consultant explained more around this issue:

> *"Certainly it is important to have a high level of IT sophistication within the staff working in maintaining the supporting the e-learning project. However, from our experience, the availability of a mature OS community around the product* minimised *the need for high level. From the other hand, depending on cloud computing and outsourcing the whole infrastructure again* minimised *the need for other skills to be available. We assume that a good evaluation prior implementing*

OSELA accompanied with a good systemic support plan will minimise *the need for skilful IT to be available on site. That's why we support that IT sophistication is opposite proportional to the availability of the external support."*

5.1.14 ICT infrastructure

In the beginning of the adoption process in the year 2008, the Information and Communication Technology (ICT) in *ALMEDCO* was similar characterised as most ICT infrastructure in the Higher Education sector (QAAP 2011). Poor ICT infrastructure, not integrated, ICT staff lack harmony and knowledge, and not oriented by the learning and teaching needs *(VD for Educational Affairs).* Moreover, a preliminary study showed that the cost of building a proper ICT infrastructure will exceed the allocated budget for the whole e-learning project, as well as it needing a long time to be built and stabilised *(Director of e-learning unit).* This scenario resulted in the management team choosing cloud computing and hosted services as a cheap yet efficient solution. A Hosted Service Provider is a business that delivers a combination of traditional IT functions such as infrastructure, applications, security, monitoring, storage, web development, website hosting and email, over the Internet (Fry*et al.* 2009, Laurillard 2008).

The use of OSELA did not need huge investments in local infrastructure in comparison to proprietary software that needed a suitable highly secured and well maintained client-server architecture with high Local Area Network (LAN) connectivity. The OSELA support for the use of cloud computing made it affordable to any faculty to implement a full e-learning system and pay as little as a few dollars per month. Moreover, the maintenance of servers and securing them against threats and attacks is entirely the responsibility of the host. This eliminated extra cost needed to hire high professional staff to maintain the system, and at the same time raised the percentage of system up time and assured service continuity. This approach enabled *ALMEDCO* to consolidate and outsource much of their IT needs for a predictable recurring fee *(Director of e-learning unit).*

From the above discussion, it appears that the status and conditions of available IT infrastructure determined the difficulty to adopt proprietary software (non adoption of PS) and favoured the adoption of OSELA. Thus, this proves that IT infrastructure was one factor that influenced the decision to adopt OSELA.

5.2 CASE STUDY TWO – THE *ALDENCO*

5.2.1 Background to the organisation

ALDENCO is a public Dental College that traditionally operates in the higher education sector. *ALDENCO* was established in 1945 as part of an attached medical school. In the first academic year in 1945/1946 it had only two students. *ALDENCO* separated in 1970 to form a unique identity.

ALDENCO now has ten academic departments. It offers a number of degrees in different programmes (Bachelor, Diploma, Master, Doctor of Medicine and Surgery in seven fields, and Doctors of Philosophy in Medicine in four fields).

ALDENCO serves the community in its city and the neighboring cities by being in the centre, providing quality dental care and increasing the oral health awareness of the community. In addition to the well-equipped clinics within *its* premises, *ALDENCO* organises dental convoys with a fully equipped mobile dental unit, supervised by its faculty and staff members to areas lacking dental services.

ALDENCO consists of two academic buildings. It has up to 1,500 students in the undergraduate studies, and 500 in the post graduate studies. The undergraduate studies consist of 1 main programme. The post graduate studies offer three degrees – Diploma, Masters, and Medical Doctorate in about fifteen specialties. The college's ten academic departments are supported by around 115 full time academic staff.

5.2.2 Background to e-learning adoption drivers

By the end of 2009, the administration of *ALDENCO* realised it was late in implementing e-learning in its educational system. "Limited knowledge was available on how E-Learning should be of benefit for teaching in practical medical field" said the dean of the

college *(Dean of ALDENCO)* explaining the delay. Faced by dental colleges in other universities that have already implemented E-Learning and for *ALDENCO* to keep up with them it had to act fast. Nevertheless, for post graduate studies, the college was losing prospectus candidates that favoured online programmes rather than attending class based courses *(VD for Educational Affairs)*. The two main reasons behind this new direction was due to: (1) the availability of new accredited online courses offered by internationally recognised institutes, and (2) many of our postgraduate students are already working full time in the morning and the majority are working in private clinics in the afternoon. Those reasons put pressure on the administration to seek non-traditional ways to retain students and to offer them better time table for learning *(VD for Educational Affairs)*.

Whilst it is of great importance for *ALDENCO* to take its position as one of the best dental schools in the area, many challenges are to be overcome. The main problems that were caused by the existing traditional educational system as summarised from all *ALDENCO* interviews are the following:

1. *ALDENCO* with only two buildings has not enough classrooms to accommodate the huge number of students.
2. Huge number of students (2000) to be taught by a smaller number of staff members (115).
3. Lack of college facilities to support the teaching process (limited number of computer labs, no educational centres, etc.)
4. Lack of materials and book (usually written and printed by the different departments of the college to be sold to the students at low rates).
5. Books available are of very low quality (books are photocopied because it is cheaper than printing resulting the fact that most of the figures are not clear to see and study).
6. Students of the college come from distant places (waste of time in travelling from and to college, lack of comfortable and flexible methods of transportation).
7. No support from government in funding the development of the college.

Having the potential of putting E-Learning into practice, *ALDENCO*, like many other colleges, applied for the QAAP and obtained the funds required to deploy a campus wide e-learning project. Dean of *ALDENCO* expressed great interest in e-learning when she was asked to give her opinion:

> *"From the practices that we witnessed in the last couple of years nationally and internationally in the field of Dental education, we believe implementing E-Learning in our colleges will help solving many problems in managerial, pedagogical, administrative levels"*

Still *ALDENCO* had no reference to start from to implement E-Learning properly. There was ambiguity surrounding the proper implementation, and many issues needed further investigation, such as technical needs, cost, staff resistance, students readiness, lack of evaluation framework for the existing available systems, and above all well-designed strategic and action plans. *(Local Director of QAAP).* Yet, most of the interviewees shared the common view that the surrounding environment has many positive indicators for implementing E-Learning in *ALDENCO* (Head of e-learning committee). Some of these indicators are listed below:

1. E-Learning will encourage the students to depend more on self-learning.
2. There is a very effective participation from staff members and students in the usage of technology (especially the web) in the educational process.
3. The new generations (Generation Y) are computer literate. Introducing them to e-learning will not be difficult and will improve the quality of their education.
4. The availability of Broadband internet connectivity with affordable prices to both students and faculty members.
5. Students' tendency to use of Cyber Cafes that is available all around.

6. The popularity of social networks among the new generations which can be used to facilitate learning in general.
7. Staff's increasing awareness of the electronic libraries and their usage.
8. Availability of educational web sites with different types of learning materials.
9. Readiness of the government to improve the quality and enhance the infrastructure of information technology.
10. Many projects and initiatives that provide computers for students at affordable prices and with the option of paying in installments.
11. *ALDENCO*'s current condition (large number of students, low number of staff, lack of good resources, and bad quality of learning materials) paved the way for the use of e-learning.

5.2.3 Motivation to OSELA adoption

ALDENCO was falling behind other local colleges and universities in implementing E-Learning, and after being under pressure from the government, as well as the community to improve and enhance the quality of education through technology, several learning styles and techniques were proposed by the administration and the faculty. However, there was a lack of a clear vision and roadmap for the implementation procedures. Many in the faculty had personal experience in teaching or even learning from other colleges' E-Learning systems, yet they had no experience in the implementation process itself *(Head of e-learning committee)*. Several discussions took place with different stakeholders to decide the most appropriate approach to follow. Unfortunately, there was not a clear or unified method for E-Learning implementation to be followed. The faculty administration took a decision to hire an external consultant with past experience in implementing E-Learning system especially in the medical field to assist the faculty in their decision *(Dean of ALDENCO)*.

ALDENCO was taking part in a new field, therefore, in order to use E-Learning effectively to achieve the aim of enhancing education they required a thorough analysis of their

situation and a full awareness of all potential benefits that could be gained by E-Learning implementation.

However, taking into consideration that *ALDENCO* has limited funds and large amounts of students they found that the best possible option was to use an open source e-learning application such as OSELA. The proposed solution was Licence free, well tested worldwide, and with a proven educational reputation (used in many universities and schools). One of the major reasons for choosing this software is directly related to limitations in financial resources. The cost factors had influenced not only the decision to adopt OSELA, but also the decision for introducing e-learning at all. Furthermore, for the majority of users e-learning was summarised in the use of the OS LMS, namely: MOODLE, this had to be further explained as e-learning is not just the LMS deployment but contains a full spectrum of changes that need to be incorporated with the implementation project.

5.2.4 OSELA adoption process

Once the cost issue was resolved and the decision was taken to use OSELA, the attention was then focused on commencing the implementation. *ALDENCO* realises that it would be a worthy challenge to fully computerise the institution and create a new learning environment both academically as well as administratively.

The faculty's strategic plan was "to reach an open system for learning and teaching," provided learning that should be activity based and centered around the student, and teaching is something that can be done anytime, anywhere *(Local Director of QAAP)*. The simple part about implementing the open source system was that it would be the "first" information system to be used in *ALDENCO*. No other information system existed (learning, administrative, financial, student information or human resources); all the core business activities were run and operated in paper form. Therefore the problem of migration or conversion from one system to another would not arise.

A committee was then formed of members from the Medical Education department, Faculty Administration, ICT department and external e-learning consultants. They would study and plan for the integration of the open source e-learning environment. Among their goals was to choose and explore available open source applications specifically designed for higher education.

5.2.5 Evaluation of OSELA

The aim of the E-Learning committee at *ALDENCO* was to identify the features that could be applied to enhance student learning *(App.1, 2)*. One could say that the need to improve the quality of education was derived by technology usage. Indeed the technology brought much facilitation on the way students learn, especially in medical schools, but the major impact of networks and the internet is that it helped people to interconnect at any time. The advantage of OSELA was that it was the perfect balance between technologists and academics. Although it was developed by technologists, academics could identify their needs and requirements and review the application, allowing technologists to tailor the code to their specific needs at minimal cost and open their desire.

> *"The ability to add any open source learning application to the existing platform with no extra cost, gave us confident in the system and the ability to plan for a long term expansion plan without the fear of facing new technological obstacles or barriers." (Head of e-learning committee)*

5.2.6 Assessment of the proposed Evaluation Framework for OSELA adoption

The following sections describe the use of the novel evaluation framework that was proposed in section (3.4) within the *ALDENCO*. In order to have a multiple views, three of the stakeholders directly involved in the adoption and implementation of OSELA were interviewed. Interviewees were interviewed using structured interviews. Interviewees

included: (a) Head of E-learning Committee (HE), (b) Local Director of QAAP (DQ), and (c) an External Consultant (EC).

The author asked the interviewees to indicate how important each evaluation criteria was and then, to assess the selected applications using the three categories of evaluation criteria Table (3.2). The evaluation follows the scale of ranking used by Miles and Huberman (1994) to assess the different applications.

Application Requirements	HE	DQ	EC
Maturity	●	●	●
Community	●	●	●
Longevity	◉	●	◉
Licence	●	●	●
Support	●	●	●
Documentation	●	◉	●
Security	●	●	●
Functionality	●	●	●
Interoperability	●	●	●
Customisability	●	●	●
IT and Web profile	◉	◉	◒

Table 5.6: Importance of Application requirements at *ALDENCO*

As illustrated in table (5.6) it appears that interviewees have similar perceptions related to application requirements and issues. In interpreting the empirical data, it is clear that nearly all application requirements are considered to be of great importance. However, there is a difference in their answers regarding: (a) Longevity and (b) IT and Web profile.

When asked for a justification of rating the IT and web profile to be of medium importance, the Local Director of QAAP was quite confused regarding this issue, a justification came from Head of E-Learning Committee who stated that:

"In today's world of networks, it is always possible to connect and interconnect systems. Systems reside on different platforms and databases. The integration is not a very important issue that might eliminate a successful application or system to be added to any platform. Of course there will be extra work and extra cost, that's why we rated of medium importance. It should be considered, but it shouldnot alter the adoption of a non compatible application."

When the interviewees were asked to justify the reasoning behind rating Longevity to be of medium importance, Local Director of QAAP answered:

"Technology is changing rapidly. The newest technology today could be outdated within the coming three years. In the other hand new technology brings new features and easy to use application, and students tend to use what is the most recent. Still, it is important to check that the adopted application has been there for a while and tested by many before deciding a large deployment."

Then the three interviewees were asked to evaluate the OS applications using the three categories of evaluation criteria Table (3.2). Table (5.7) summarises the interviewees' perceptions related to OSELA.

		Application Purpose								
		Industrial Focused			Education Focused			General		
		HE	DQ	EC	HE	DQ	EC	HE	DQ	EC
Learning	Learning management system	×	×	×	●	●	●	×	×	×
	e-Library Systems	×	×	×	●	●	●	×	×	×
	Social Learning Systems	○	○	○	●	●	●	✓	✓	✓
	Portfolio Management Systems	○		○	○		●	✓		✓
Supportive	Research Administration	×	×	×	●	●	●	×	×	×
	Conferences Management	×	×	×	◉	●	●	×	×	×
	Journal Administration Systems	×	×	×	●	●	●	×	×	×
	Portal Administration Systems							●	●	●
	Office Productivity							○	○	○
	Web Browsers							●	◉	●
Business	Student Information System	×	×	×	●	●	●	×	×	×
	Facility and Class Management	○	×	×	●	●	●	×	×	×
	Financial Management	◉	○	○	◉	◉	●	◉	◉	◉
	Human Resources Management	◉	○	○	◉	◉	◉	◉	◉	◉
Infrastructure	Operating Systems							○	○	●
	Identity Management System							◉	◉	●
	Web Servers							○	○	●
	Database Servers							○	○	●
	Unified Communication Systems							○	○	●

Table 5.7: *ALDENCO* evaluating OSELA using application purpose

5.2.6.1 Application Purpose category

Interviewees reported that to their knowledge certain categories of application do not have special edition directed to higher education users, specifically the infrastructure category. In the same context, the local director of QAAP seemed confused about the use of a portfolio systems in education and preferred not to answer questions related to it.

Table (5.7) summarises the answers of the three interviewees when they were asked to evaluate OSELA using application purpose. It appears from these answers that interviewees shared the same perception in the Learning and Supportive categories. However, there was confusion surrounding the use of portfolio systems. On the contrary, in the category of infrastructure, the views were controversial. The head of e-learning committee reported that:

> *"Using open source infrastructure does not seem to be of high importance. The ability of OSELA to run on different platforms made the use of well-known proprietary software possible. In our environment, the open source movement is totally new and we lack talented IT staffs that are aware of open source technologies. In the opposite, for many years, various training grant were offered to thousands of graduates to use top international proprietary software making a strong availability of labour when needed. In the same, the use of proprietary software will focus the lack of OS staff in the application layer only therefore decrease the barrier of finding IT staff"*

With regard to supportive applications, interviewees found the separation of office productivity and web browsers (suggested by *ALMEDCO*) to be logical. For the office productivity systems, interviewees did not recognise the need to deploy a web based office system rather than each user having his/her own personal version.

5.2.6.2 E-learning mode category

Thereafter, interviewees were asked to assess OSELA using the e-learning mode category. Table (5.8) represents the evaluation results.

		e-learning mode								
		Blended e-learning			Online Blended e-learning			Self Based e- Learning		
		HE	DQ	EC	HE	DQ	EC	HE	DQ	EC
Learning	Learning management system	●	●	●	●	●	●	●	●	●
	e-Library Systems	◉	●	◉	●	●	●	◉	●	●
	Social Learning Systems	○	◉	●	●	●	●	○	◉	○
	Portfolio Management Systems	●		●	◉		◉			
Supportive	Research Administration	◉	◉	◉	◉	●	●	◉	◉	●
	Conferences Management	◉	○	◉	◉	◉	◉	○	○	◉
	Journal Administration Systems	◉	◉	◉	◉	◉	●	○	○	◉
	Portal Administration Systems	●	◉	●	●	◉	●	○	○	◉
	Office Productivity	○	○	○	○	○	○	○	○	○
	Web Browsers	●	◉	●	●	◉	●	●	◉	●
Business	Student Information System	●	●	●	◉	●	●	○	◉	◉
	Facility and Class Management	●	●	●	×	×	×	×	×	×
	Financial Management	◉	●	◉	●	●	●	●	●	●
	Human Resources Management	○	○	◉	○	○	◉	○	○	×
Infrastructure	Operating Systems	○	○	●	○	○	●	○	○	●
	Identity Management System	○	○	●	○	○	●	○	○	○
	Web Servers	○	○	●	○	○	●	○	○	●
	Database Servers	○	○	●	○	○	●	○	○	●
	Unified Communication Systems	○	○	●	○	○	●	○	○	○

Table 5.8: *ALDENCO* evaluating OSELA using e-learning mode

Table (5.8) shows the assessment of OSELA by interviewees using the e-learning modes as evaluation criteria. Based on their answers it appears that only learning management systems are found to be important in all e-learning modes. The interviewees' perceptions on

the use of OS infrastructure are still consistent with table (5.7). However, for the learning category, interviewees seem to share almost the same perception.

With regard to the Self based e-learning mode, it was in the interviewees believe that this mode is not applicable in medical practical studies (i.e. medical, nursing, dental, etc.) where students need to practice the knowledge, and most of the assessment is based on skills and interaction with patients. Still, there are some specialised courses (i.e. Continuous Medical Education) and few topics that interviewees considered to be applicable to this e-learning mode (i.e. theoretical courses, Public health, community health, etc.). For these specific types of courses, all interviewees shared the same perspective with the head of e-learning committee explaining:

> *"In self based e-learning mode, OSELA do not need to be sophisticated or fully integrated to ensure the success of the learning process. The "off the shelf" courses depend on a good multimedia and automated instructional design that resides on the LMS. Moreover, students enrolling for these courses are offered to worldwide students, therefore they are not necessarily required to be registered in the college."*

The following table (5.9) summarises all answers from *ALMEDCO* interviewees.

		Application Purpose									e-learning mode								
		Industrial Focused			Education Focused			General			Blended e-learning			Online Blended e-learning			Self Based e- Learning		
		ELU	ME	EC	ELU	ME	EC	ELU	ME	EC	ELU	ME	EC	ELU	ME	EC	ELU	ME	EC
Learning	Learning management system	×	×	×	●	●	●	×	×	×	●	●	●	●	●	●	●	●	●
	e-Library Systems	×	×	×	●	●	●	×	×	×	⦿	●	⦿	●	●	●	⦿	●	●
	Social Learning Systems	○	○	○	●	●	●	✓	✓	✓	○	⦿	●	●	●	●	○	⦿	○
	Portfolio Management Systems	○		○	○		●	✓		✓	●		●	⦿		⦿			
Supportive	Research Administration	×	×	×	●	●	●	×	×	×	⦿	⦿	⦿	⦿	●	●	⦿	⦿	●
	Conferences Management	×	×	×	⦿	●	●	×	×	×	⦿	○	⦿	⦿	⦿	⦿	○	○	⦿
	Journal Administration Systems	×	×	×	●	●	●	×	×	×	⦿	⦿	⦿	⦿	⦿	●	○	○	⦿
	Portal Administration Systems							●	●	●	●	⦿	●	●	⦿	●	○	○	⦿
	Office Productivity							○	○	○	○	○	○	○	○	○	○	○	○
	Web Browsers							●	⦿	●	●	⦿	●	●	⦿	●	●	⦿	●
Business	Student Information System	×	×	×	●	●	●	×	×	×	●	●	●	⦿	●	●	○	⦿	⦿
	Facility and Class Management	○	×	×	●	●	●	×	×	×	●	●	●	×	×	×	×	×	×
	Financial Management	⦿	○	○	⦿	⦿	●	⦿	⦿	⦿	⦿	●	⦿	●	●	●	●	●	●
	Human Resources Management	⦿	○	○	⦿	⦿	⦿	⦿	⦿	⦿	○	○	⦿	○	○	⦿	○	○	×
Infrastructure	Operating Systems							○	○	●	○	○	●	○	○	●	○	○	●
	Identity Management System							⦿	⦿	●	○	○	●	○	○	●	○	○	○
	Web Servers							○	○	●	○	○	●	○	○	●	○	○	●
	Database Servers							○	○	●	○	○	●	○	○	●	○	○	●
	Unified Communication Systems							○	○	●	○	○	●	○	○	●	○	○	○

Table 5.9: *ALDENCO* evaluating OSELA using Application purpose and e-learning mode

5.2.7 Pilot of OSELA Adoption

The pilot project involved the use of three OSS applications, namely: (a) Learning Management System (LMS), (b) Content Management System, and (c) E-mail Systems. The selection of the three application were done through three steps: (a) analysis of the college e-learning requirements and needs conducted by an external consultant, (b) the external consultant provided a list of potential solutions with comparison charts among them, and finally (c) a stakeholders meeting involving representatives from the e-learning committee, staff members, students representatives, management, and administrative personnel. All applications were deployed in OSS infrastructure comprising of server operating system, web server, and database server.

After the deployment of the OSELA, the e-learning committee evaluated the use of e-learning in general and the use of OSS in specific. In addition, with direct observations from the E-Learning committee members to assess benefits and drawbacks of the project, the committee was able to identify benefits, barriers and costs of following through with the complete integration.

5.2.8 Benefits

The interviewees were then asked to identify the benefits of using open source software. Their answers were perfectly matched with (Machado, 2005) model and are summarised as follows:

> **Economically:** All interviewees agreed that the cost of e-learning implementation was far below expected. Yet most of the goals set by the college management were achieved. Implementation can be carried out at no additional payments or costs. Normally implementing a new teaching technology would be met with resistance from both students and staff thus producing extra costs, especially if software was to be purchased. Plus taking

into account the time needed to build the e-learning courses, teach the students and train the teachers, the cost would continue to rise. The use of OSELA gives *ALDENCO* the opportunity to nurture this technology while still in its infancy without any extra costs.

Technically: The installation of the LMS was very systematic and the applications were easily deployed. Moreover, adding and content management system to the platform was carried out without any extra cost. On the other hand, by using mature LMS *ALDENCO* did not need to hire developers to access the code for any extra customisation. The choice of OSELA has proved to be successful. At any given time when there is a need to apply the source, it is simply downloaded and installed. Furthermore it is easy to integrate different applications to benefit from integrated services since they all follow the Global Public Licence (GPL).

Pedagogically: OSELA proved to use constructive teaching methods allowing teachers to use various learning styles in their course. The variety of functions and the rate of developing new modules within the community of the OSS made it rich with different tools that fit different learning styles and techniques. Its applications are easy to use and better to understand by teachers. The OSELA proved to be a good marriage between tutors and technology.

Philosophically: Unlike commercial sellers looking to sell their product for the best deal, open source applications are released with the attitude of gaining and sharing knowledge. The structure of open source communities is closely related to the nature of higher education. This fit of culture made the acceptance among academic staff, which usually resist technology use in learning, more confident and trusted the use of OSS.

5.2.9 Barriers

The author asked the interviewees to determine the barriers to the implementation of OSELA. All interviewees agreed that OSELA implementation is a complex project that depends on a clear vision from the management board. Many barriers were discovered during the implementation and are summarised as follows:

1. There are still a lack of personnel in positions that need to be filled by e-learning staff with skills. There is still a need for an Educational Technologist, Instructional Designers and e-learning specialists. Furthermore these individuals will require large salaries and *ALDENCO* does not intend to support this huge pay.
2. Because the open source project is run by individuals and not by an enterprise, there is always a risk of discontinuity if people are not available. Also there is no existence of 3rd party centres for technical support, training and troubleshooting.
3. There is no support in the local community for open source.
4. The resistance to change is still evident in older faculty members who see the new system as a replacement to the old one and not supplementary to it. This lack of support and knowledge acts as a barrier for implementation of the e-learning concept and strategy.
5. Faculty members also look at open source as something experimental and immature, while others presume that because it is free it must be lacking features that are available in paid versions.
6. The risk of lack of feedback from the communities regarding troubleshooting.
7. OLESA is not allowed to use certain types of data and records (student registration system and test banks). This type of data must be stored locally, thus creating the potential for redundant databases between the local and online records.

5.2.10 Costs

The cost of deploying e-learning in *ALDENCO* was the most influential factor. While proprietary software was very high and far above budget, the promise of free software was very tempting. Initially, the term free was misleading, implying that there would be no cost to *ALDENCO* which proved to be only true with regards to the Licence fees. *ALDENCO* realised it had to provide the cost of implementation, maintenance, and training. Moreover, *ALDENCO* had to hire IT staff with relatively high salaries. Thus, *ALDENCO* noticed that these hidden costs associated with OLESA are still generally very low in comparison with similar proprietary software. Interviewees were then asked to identify where the additional costs lay, and the summary of their answers is presented in table (5.10). The table below analyzes the costs of OSELA at *ALDENCO* based on its relative value and derived from all interviews conducted:

Category		Cost Item	Description	Value
Direct Cost	Technology Costs	Initial Licence	Purchasing price	*Not available*
		Annual Licence	Renewal fees	*Not available*
		Maintenance	Staff time	Low
		Upgrade	New version price	*Not available*
		Hardware Costs	Rented from SAAS provider	Medium
		Web hosting Costs	Rented from SAAS provider	Low
Indirect Cost	Human Costs	Support	Purchased from 3rd party, community	Medium
		Integration & Interoperation	Easily modified by staff, shared from other institutes	Medium
		Customisation & Localisation	Easily modified by staff	Low
		Consultancy Costs	External Consultancy	**High**
		New IT employee salaries	IT staff with OSS related skills	Medium
		Academic Staff training	Training on using the application	Low
	Organisation Costs	Managing resistance of change	Seminars, workshops, group discussions	Medium
		Reorganisation of the curriculum	Staff and academic consultant time	Medium
		Restructuring of the organisation	Consultancy and staff time	Medium
		Business process reengineering	3rd party and consultancy	**High**

Table 5.10: Classification of *ALDENCO*'s OSELA adoption costs

5.2.11 Support

When asked about the importance of the availability of support for OSS applications, Interviewees reported that they had to rely on the community to provide knowledge and tutorials on the functionality of the application. However, for technical support and due to the absence of IT department in *ALDENCO*, the best solution was to purchase the service from a third party. Eventually, the factor of support was crucial in the adoption decision, the e-learning committee head commented:

> *"The availability of community and online support was motivating us towards the adoption of OSS. But due to the fact that we did not have IT personnel, the plan was to hire new employees and rely on a third party as an extra precaution for the first year. The flexibility to choose from different third parties service providers and not to be attached to only the vendor support gave us more confidence in our decision."*

5.2.12 External Pressure

Along with all of the medical colleges in Egypt and for many decades, *ALDENCO* was operating in a non competitive environment. *ALDENCO* had a large demand, and students for undergraduate programmes were admitted through the ministry admission system. For the post graduate studies, the demand was still high and mostly from the same student who graduated from the undergraduate programme.

However, recently *ALDENCO* had a new competitor with the inauguration of a new private university that had a similar college. The competitor did not only attract potential students but also many academic staff. *ALDENCO* aiming to gain more competitive advantages had to think of e-learning as a possible new channel for international and national students. However, competition also existed with many other medical colleges applying to the

QAAP project. Each medical school was trying to implement their e-learning within the available budget and time limit. Finally, considering other successful OSS implementation in other colleges put a high pressure on the use of OSELA.

5.2.13 IT Sophistication

For many years *ALDENCO* did not have an IT department. When interviewees were asked for reasons, the Local Director of QAAP explained:

> *"Since medical education did not contain any IT studies in its curriculum and most of the administration was done manually on paper, there was limited need to establish an IT department. Even with the raising of IT usage in different colleges, the desire to introduce technology into ALDENCO was always faced by lack of fund and human resources."*

However, the absence of skillful IT staff could hinder the implementation of OSS. As the main advantage of OSS is the ability to contact community and support online, solve problem internally with the source code available and the applications are highly interoperable and customisable. On other hand IT sophistication had influenced the decision to adopt OSELA. For that reason, *ALDENCO* recruited IT personnel to work within the e-learning committee in the OSELA implementation project.

5.2.14 ICT infrastructure

Since its foundation, little attention was given to the use of IT in education. There is no IT department in *ALDENCO*, only one computer lab connected to the Internet for faculty and student use is available *(E-learning Consultant).* The main reasons for this poor structure are: (a) the limited fund available was directed for medical laboratories and medical equipment (these already suffer from lack of funds), (b) IT did not have any significant role

in the education process, and (c) previous administrations did not recognise the role of IT in education and learning processes.

ALDENCO received QAAP funding but it was insufficient to build a suitable IT infrastructure or to have a suitable number of computer labs. The funding was used to build small sized labs with minimum equipment. *ALDENCO* decided not to waste the funding on the purchase of servers and decided to depend on Software As A Service (SAAS) providers. This type of technology provides a cost efficient solution including all IT functions needed, such as infrastructure, applications, security, web development, web hosting and email over the Internet *(E-learning Consultant).* Also, the use of SAAS will cut down on the cost of server maintenance, server security and the need to hire professional staff as it will be the responsibility of the host.

5.3 CASE STUDY THREE – THE *MAMEDCO*

5.3.1 Background to the organisation

MAMEDCO is a public medical college that traditionally operates in the higher education sector. *MAMEDCO* was established in 1962, it consists of one academic campus, five Super Specialised medical centres, and four university hospitals running clinical and medical research programmes. It has up to 3000 students in undergraduate studies, 1,500 in post graduate studies. The undergraduate studies consist of two main programmes namely: (a) the national programme, and (b) the international programme. The post graduate studies offer three degrees – Diploma, Masters, and Medical Doctorate- in thirty specialties. The college has 29 academic departments with around 500 full time academic staff. The medical education department is the department responsible for the development of education in the college, and the Medical e-learning unit is responsible for all e-learning activities within the college. *(MAMEDCO website)*

5.3.2 Background to e-learning adoption drivers

Though, *MAMEDCO* is considered to be one of the centres of excellence in certain specialties in Egypt and in the whole Middle East area, it faced deterioration in the quality of medical education since the eighties of the last century as did most of the medical colleges in Egypt. *(Dean of MAMEDCO)* "The reasons for this decreasing quality are on the national level," said the dean and vice dean for educational affairs, and they are not just limited to:

1. Large number of students versus scarce resources (financial, faculty staff, classrooms, labs, theatres, etc.).
2. Almost all the buildings were built in the sixties with no plan for expansion or to encompass the increasing number of students.
3. Most of the faculty is busy either in the hospitals or their private clinics.
4. Lack of a proper textbooks and learning material.

5. Up-to-date studying in medical public schools is free, resulting in very low salaries to the faculty and limited resources to update equipment or classrooms.

For many years, medical schools, among other schools, were left to draw their own educational policies and regulations. Moreover, within medical schools, departments might have different teaching procedures or learning policies *(VD for Educational Affairs)*. These wrong practices were cumulating over the past years putting *MAMDECO* among all national public medical schools away from international standards of medical education.

Fortunately, this came to an end due to the projects initiated by the MOHE to enhance the quality of education in the higher education sector. One essential project is the QAAP. For three years, funding and resources are allocated to overcome the problems that have accumulated throughout the last three decades. The output of this project is to qualify and accredit colleges according to the national standards. The project tackled problems at all levels (managerial, administrative, pedagogical, technical, etc.) and established frameworks and guidelines to standardise the educational procedures in all participating colleges *(Local Director of QAAP)*.

One of the major trends in enhancing medical education was the induction of technology of learning especially the wide use of e-learning. Since the introduction of the Internet in Egypt in the early 2000's, the World Wide Web offered a new media for educational materials and resources. The way of delivering these educational resources are constantly evolving to keep pace with new technology and format. Nowadays, educational format comes in various shapes like: web text, video, animation, audio, podcasts, tele-courses and online courses. These alternative formats are creating paradigm shift especially in medical schools *(Director of e-learning unit)*.

In *MAMEDCO*, starting in 2006, the movement was unprecedented. Students were able to browse the web individually for contents that facilitates their understanding and assist them in building their knowledge. At the same time, staff members started to use the internet to collect data for their courses directs the students to use the internet to learn, and use many new educational technologies –especially simulations and animation – in their classrooms. Such an "uncontrolled" movement led to some challenges that had to be overcome. Copyrights – Reviewed contents– Consistency – Trust – aligned with curriculum *(Director of e-learning unit).*

As a reflection of this new expanding environment, the faculty decided in 2009 to adopt e-learning as another channel for education delivery. The decision was influenced by two main factors: (1) the increase of the use of "uncontrolled" educational materials by students and staff, and (2) Nationwide direction to use new methods for teaching and learning in the universities *(VD for Educational Affairs).* The uncontrolled use of the Internet by both students and staff put some internal pressures on the administration of the college to speed up the process of e-learning implementation *(Director of e-learning unit).* While the Internet is rich in information and materials, not all sites are trusted and reviewed. Staff importing some good looking materials could face teaching contents that are not aligned with the objectives of the course. Meanwhile students were assuming all information gathered from the Internet to be true. The college administration reported some cases where students were misled by incorrect information brought from certain internet sites.

Since that time, *MAMEDCO* had its own plans for education reform. Many initiatives took place on a small scale to enhance the way students learn and the methods by which the lecturers teach. One of those initiatives was the establishment of the E-learning unit to promote the use of technology in education and inducing e-learning techniques in the curriculum. The Medical E-learning unit was established to: (1) Facilitate flexible medical e-learning solutions and access new learning technologies, (2) Offer a structured and professional study environment, and (3) Widen and enhance staff and student opportunities and release their potential by providing the most up-to-date highly integrated learning

information and communication technologies solutions to meet promptly their dynamic needs and challenges *(Director of e-learning unit).*

5.3.3 Motivation to OSELA adoption

At its beginning, the E-learning unit at *MAMDECO* used home grown "custom made" applications. The available proprietary software was very expensive and out of budget. Custom applications were designed and programmed by local ICT professionals in *MAMDECO* University from the computer sciences college. Though custom applications were tailor made to the specifications and requirements of the *MAMDECO* staff, it took a long time to develop and after implementation, they needed further support and effort to eliminate some bugs and flaws that affected the efficient operation of those applications *(Local Director of QAAP).*

Eventually, cost and time for deploying e-learning in *MAMEDCO* became the top factors influencing the decision to select the software. The developed applications were sufficient for a while; however, to keep pace with students accelerating needs, rapidly changing technology and fast growing use of e-learning, *MAMEDCO* had to figure out alternative methods *(VD for educational Affairs). MAMEDCO* realised that for an institution-wide e-learning application, developing its own software can be prohibitive. Three of the stakeholders involved in the implementation of e-learning noted some problems involved in the implementation process *(VD for Educational Affairs, Local Director of QAAP, Head of e-learning unit)*:

1. There is limited knowledge on the role and needs for e-learning platform among the staff and the students.
2. There is a immense resistance to use e-learning in medical studies among the faculty staff that did not trust the local product to fit with their pedagogical objectives.

3. Staff members are over burdened by academic loads. Moreover, they are required to engage in large amount of documentation and quality procedures related to QAAP project. The quality procedures, which are a totally new domain for the majority of the staff, needed them to attend seminars and workshops to learn more about it.
4. For the above mentioned reasons, staff lack the time to learn about e-learning project and leave fewer interested staff to participate in preparation or implementation activities.
5. Yet there is no framework to evaluate the available e-learning platforms, nor to define the requirement of higher education institutes in general and the medical schools in particular.
6. The action plan was based more on a "trial and error" strategy; there was a lack of best practices and case studies.
7. Seeking proprietary software increased the problem as they acquired Licence fees that were beyond their budget. Moreover, due to the current situation, there was an expectation that it will take more than a couple of years before getting the best out of the system, which give way to more unwanted expenses.

5.3.4 OSELA adoption process

By the time many faculties and universities joined the QAAP initiative, seminars and workshops were conducted to raise awareness of E-learning in general. During one of these meetings the term Open Source Learning Management Systems appeared to be one of the best-proposed solutions to *MAMDECO*. The head of e-learning unit explains:

> *"Due to lack of time of implementation and limitation of financial and human resources, the open source learning management systems are favoured over the custom made applications that we used to*

adopt. Systems are ready to be deployed at no charges and one can start using and testing them immediately."

However, based on their past experience with home grown applications, *ALDENCO* were able to identify some problematic areas to assess in the proposed LMS. Moreover, the e-learning unit had prepared reviews and comparison between their implemented application features and the features of the OSLMS. After a comprehensive features evaluation, the OSLMS proved to be more appropriate and efficient solution *(Director of e-learning unit).*

Once *MAMEDCO* decided to implement e-learning using Open Source Software, the technical process was easy. They agreed upon LMS which was backed up by the University administration, and was already installed on their servers. The main concern was on data migration and the total cost of ownership *(Local Director of QAAP).*

5.3.5 Assessment of the proposed Evaluation Framework for OSELA adoption

The next sections describe the use of the novel evaluation framework that was proposed in section (3.4) within the *MAMEDCO*. In order to have multiple views, three of the stakeholders directly involved in the adoption and implementation of OSLMS were interviewed. They were interviewed using structured interviews. Interviewees included: (a) Director of E-learning unit (DE), (b) Local Director of QAAP (DQ), and (c) Vice Dean for educational affairs (VD). The author asked the interviewees to indicate how important is each evaluation criteria was and then, to assess the selected applications using the three categories of evaluation criteria (Table 3.2). The evaluation follows the scale of ranking used by (Machado, 2005) to assess the different applications.

Application Requirements	DE	DQ	VD
Maturity	●	●	●
Community	●	●	●
Longevity	●	●	●
Licence	●	●	●
Support	●	●	●
Documentation	◉	◉	◉
Security	●	●	●
Functionality	●	●	●
Interoperability	◉	◉	◉
Customisability	●	●	●
IT and Web profile	◉	◉	◉

Table 5.11: Importance of Application requirements at *MAMEDCO*

As illustrated in table (5.11) it appears that interviewees have similar perceptions related to application requirements and issues. In interpreting the empirical data, it is clear that nearly all application requirements are considered to be of great importance. However, there is a rate of medium importance for three criteria: (a) Documentation, (b) interoperability, and (c) IT and Web profile.

When asked for a justification of rating the IT and web profile was thought to be of medium importance, justification came from Head of E-Learning Committee who stated that:

> *"The e-learning application "LMS" is a full package that comes with all the needed features. Even more, the community always provides more modules to be added to the e-learning application. We at MAMEDCO believe that the IT infrastructure and web profile should follow the needs of the LMS and not the opposite. The same should apply with any MEGA application that contains multifunction and works in a multidimensional environment."*

When the interviewees were asked to justify the reasoning behind rating Interoperability to be of medium importance, Local Director of QAAP answered:

> "As we believe in specialisation, we count on each application to provide all the features necessary to fulfill our goals. The ability to interoperate with other application is important but should not be a barrier in adopting a suitable application."

The three interviewees were then asked to evaluate the OS applications using the three categories of evaluation criteria Table (3.2). Table (5.12) summarises the interviewees' perceptions related to OSELA.

		Application Purpose								
		Industrial Focused			Education Focused			General		
		DE	DQ	VD	DE	DQ	VD	DE	DQ	VD
Learning	Learning management system	×	×	×	●	●	●	×	×	×
	e-Library Systems	×	×	×	●	●	●	×	×	×
	Social Learning Systems				●	●	●	✓	✓	✓
	Portfolio Management Systems				●	●	●	✓	✓	✓
Supportive	Research Administration	×	×	×	●	●	●	×	×	×
	Conferences Management	×	×	×	◉	●	●	×	×	×
	Journal Administration Systems	×	×	×	●	●	●	×	×	×
	Portal Administration Systems							●	●	●
	Office Productivity							○	○	○
	Web Browsers							●	◉	●
Business	Student Information System	×	×	×	●	●	●	×	×	×
	Facility and Class Management	×	×	×	●	●	●	×	×	×
	Financial Management	◉	○	○	◉	◉	◉	◉	◉	◉
	Human Resources Management	◉	○	○	◉	◉	◉	◉	◉	◉
Infrastructure	Operating Systems							○	◉	◉
	Identity Management System							◉	◉	◉
	Web Servers							○	◉	◉
	Database Servers							○	◉	◉

Table 5.12: *MAMEDCO* evaluating OSELA using application purpose

5.3.5.1 Application Purpose category

Table (5.12) summarises the answers of the three interviewees when they were asked to evaluate OSELA using application purpose. It appears from these answers that interviewees shared the same perception in almost all four categories. However, there was an emphasis on the importance of applications to be educationally focused in both Learning and supportive categories. The Vice Dean for educational affairs justified:

"It is very important that learning applications be focused on special Higher education needs and requirements. The domain of higher education is different than other educational domains (commercial training, corporate training, elementary education, etc.). While the core business of colleges and university is education, it is crucial that adopted systems in these two categories (learning and supportive) fit the higher education culture."

Meanwhile, using open source infrastructure does not seem to be of high importance to *MAMEDCO*. Supporting both *ALMEDCO* and *ALDENCO*, interviewees did not recognise the need to deploy a web based office system and found the separation of office productivity and web browsers (suggested by *ALMEDCO*) to be logical. Thereafter, interviewees were asked to assess OSELA using the e-learning mode category. Table (5.13) represents the evaluation results.

5.3.5.2 E-learning mode category

Table (6.13) shows the assessment of OSELA by interviewees using the e-learning modes as evaluation criteria. Based on their answers it appears that interviewees share the same perception in almost all criteria. For both LMS and Financial systems the rate was important. On the contrary office productivity, web browsers and unified communication systems were found to be of low importance and not applicable in OSELA. The e-learning director reported:

"We found office and web browser to be a more personal and individual choice. We recommend neither OSS nor property. Moreover, we do not think these specific criteria are of any importance at all in deploying e-learning."

		e-learning mode								
		Blended e-learning			Online Blended e-learning			Self Based e- Learning		
		DE	DQ	VD	DE	DQ	VD	DE	DQ	VD
Learning	Learning management system	●	●	●	●	●	●	●	●	●
	e-Library Systems	◉	●	◉	●	●	●	○	○	○
	Social Learning Systems	●	●	●	●	●	●	○	○	○
	Portfolio Management Systems	●	●	●	◉	◉	◉	○	○	○
Supportive	Research Administration	◉	●	●	●	●	●	◉	◉	×
	Conferences Management	◉	○	◉	◉	◉	◉	○	○	×
	Journal Administration Systems	◉	◉	◉	◉	◉	●	○	○	×
	Portal Administration Systems	●	◉	●	●	◉	●	○	○	◉
	Office Productivity	×	×	×	×	×	×	×	×	×
	Web Browsers	×	×	×	×	×	×	×	×	×
Business	Student Information System	●	●	●	◉	●	●	○	○	○
	Facility and Class Management	●	●	●	○	○	○	×	×	×
	Financial Management	◒	◒	◒	◒	◒	◒	◒	◒	◒
	Human Resources Management	○	○	◉	○	○	◉	×	×	×
Infrastructure	Operating Systems	◉	○	◉	○	○	◉	○	○	◉
	Identity Management System	◉	○	◉	○	○	◉	○	○	○
	Web Servers	◉	○	◉	○	○	◉	○	○	◉
	Database Servers	◉	○	◉	○	○	◉	○	○	◉
	Unified Communication Systems	○	○	○	○	○	○	×	×	×

Table 5.13: *MAMEDCO* evaluating OSELA using e-learning mode

With regard to the Self based e-learning mode, it was the interviewees' beliefs that this mode does not need to implement different systems. Student will have to register to the portal, pay the fees (through financial system) and then get the online course he wishes to enroll on. The use of a database enabled web site will be sufficient to achieve any colleges' self based e-learning goals. The following table (5.14) summarises all answers from *MAMEDCO* interviewees.

		Application Purpose									e-learning mode								
		Industrial Focused			Education Focused			General			Blended e-learning			Online Blended e-learning			Self Based e- Learning		
		DE	DQ	VD	DE	DQ	VD	DE	DQ	VD	DE	DQ	VD	DE	DQ	VD	DE	DQ	VD
Learning	Learning management system	×	×	×	●	●	●	×	×	×	●	●	●	●	●	●	●	●	●
	e-Library Systems	×	×	×	●	●	●	×	×	×	◉	●	◉	●	●	●	○	○	○
	Social Learning Systems				●	●	●	✓	✓	✓	●	●	●	●	●	●	○	○	○
	Portfolio Management Systems				●	●	●	✓	✓	✓	●	●	●	◉	◉	◉	○	○	○
Supportive	Research Administration	×	×	×	●	●	●	×	×	×	◉	●	●	●	●	●	◉	◉	×
	Conferences Management	×	×	×	◉	●	●	×	×	×	◉	○	◉	◉	◉	◉	○	○	×
	Journal Administration Systems	×	×	×	●	●	●	×	×	×	◉	◉	◉	◉	◉	●	○	○	×
	Portal Administration Systems							●	●	●	●	◉	●	●	◉	●	○	○	◉
	Office Productivity							○	○	○	×	×	×	×	×	×	×	×	×
	Web Browsers							●	◉	●	×	×	×	×	×	×	×	×	×
Business	Student Information System	×	×	×	●	●	●	×	×	×	●	●	●	◉	●	●	○	○	○
	Facility and Class Management	×	×	×	●	●	●	×	×	×	●	●	●	○	○	○	×	×	×
	Financial Management	◉	○	○	◉	◉	◉	◉	◉	◉	●	●	●	●	●	●	●	●	●
	Human Resources Management	◉	○	○	◉	◉	◉	◉	◉	◉	○	○	◉	○	○	◉	×	×	×
Infrastructure	Operating Systems							○	◉	◉	◉	○	◉	○	○	◉	○	○	◉
	Identity Management System							◉	◉	◉	◉	○	◉	○	○	◉	○	○	○
	Web Servers							○	◉	◉	◉	○	◉	○	○	◉	○	○	◉
	Database Servers							○	◉	◉	◉	○	◉	○	○	◉	○	○	◉
	Unified Communication Systems							○	◉	◉	○	○	○	○	○	○	×	×	×

Table 5.14: *MAMEDCO* evaluating OSELA using Application purpose and e-learning mode

5.3.6 OSLMS Adoption

MAMEDCO started adopting OSLMS as its core e-learning application. The main issue was to transfer all data from the home grown application to be hosted on the new system. This task was successfully accomplished by the support of engineers from the college of computer sciences. However, MAMDECO has plans to deploy a portfolio system and journal management system. The following section summarises the perceived benefits from adopting OSLMS as seen by *MAMEDCO* interviewees. Following this, *MAMEDCO* reported some barriers to its adoption process.

5.3.7 Benefits

The author asked the interviewees to determine the benefits from the implementation of OSLMS. A summary from all interviewees recognised the following benefits:

1. The use of free software gave the E-learning unit at *MAMEDCO* the chance and the time to spread the culture of e-learning among the staff and students without paying initial fees. This could not be the case if proprietary or even custom made application were chosen, as their implementation required certain investment and sometime paying Licences without receiving the benefit from the system as yet.
2. The freedom of having the source code made the management confident of their choice. Even if in the future some features may need to be added to satisfy the requirement of the faculty, with help of programmers the system could be easily adapted.
3. The growing use of Open Source LMS in the whole higher education sector in the country minimises the risk of acting alone, when needed, help can be provided from many sources and adapted modules can be shared from sister colleges.
4. Implementing e-learning in *MAMEDCO* is not about the LMS only. Other futures and applications that are essentials for any HEI are not included in the LMS. Adopting OSS allows the easy, rapid and smooth creation of integrated e-learning Environment which all stakeholders can access.

5.3.8 Barriers

The interviewees were then asked to identify the barriers of using open source software. All interviewees agree with the Dean who reported that:

> *"After we started implementing the use of IT in general and the Internet specifically to our education, we figured out the short-comings in many aspects. Technology is not the only challenge; aligning pedagogy was a bigger challenge. Building the ICT infrastructure appeared to be an easy task when compared with changing the culture of professors and asking them to use internet to teach medical curriculum" - Dean of MAMEDCO*

Interviewees then reported many barriers that they faced. Their answers are summarised as follows:

1. Lack of accountability, in proprietary software there is always some sort of body that can be totally accountable for the software. In the case of OSELA there is no contract with the software providers. For the legal personnel in the college, it is uncommon to have a core application that is run without a contract which preserves the college rights. Meanwhile for the medical e-learning unit staff, this will lead to more individual work, research, and day to day communicating with online communities.
2. Staff members do not trust "free" software looked upon at it as an experimental phase that would be eliminated after a certain time. This feeling decreased the amount of involvement of the staff member in the e-learning initiative and projects.
3. The resistance of e-learning itself among staff effects the decision to use "non-supported" open source software.
4. Lack of knowledge of staff member on the features of Learning Management Systems and potential outcomes of e-learning applications

prevents them from fairly evaluating the OSELA. They expect that proprietary software contains more features and options.

5. There is no one open source product that integrates all applications required for the higher education sector to operate efficiently.

5.3.9 Costs

The cost for deploying e-learning in *MAMEDCO* was the main factor influencing the decision to select the e-learning software. While, the developed applications were sufficient for a long time, and costs less than proprietary software, some found problematic areas in the pedagogical impact of these applications and challenged *MAMEDCO* to select OSS as an alternative to home grown application *(VD FOR EDUCATIONAL AFFAIRS)*. Though the initial cost of OSS was zero, the total cost of ownership had to consider the budget spent on the legacy systems, which added to the total amount of money spent on the e-learning project *(LOCAL DIRECTOR OF QAAP)*. Moreover, *MAMEDCO* had to hire IT staff with relatively high salaries. Thus, interviewees were asked to identify the size of spending in different phases, and the summary of their answers is presented in table (5.15). The table below analyzes the costs of OSELA at *MAMEDCO* based on its relative value and derived from all interviews conducted:

Category		Cost Item	Description	Value
Direct Cost	Technology Costs	Initial Licence	Purchasing price	*Not available*
		Annual Licence	Renewal fees	*Not available*
		Switching cost	Data migration from old system	Medium
		Maintenance	Staff time	Low
		Upgrade	New version price	*Not available*
		Hardware Costs	Used University data centre facilities	Low
		Web hosting Costs	Used University web hosting facilities	Low
Indirect Cost	Human Costs	Support	Staff time	Low
		Integration & Interoperation	Easily modified by staff, shared from other institutes	Medium
		Customisation & Localisation	Easily modified by staff	Medium
		Consultancy Costs	External Consultancy	*Not available*
		New IT employee salaries	IT staff with OSS related skills	Medium
		Academic Staff training	Training on using the application	Low
	Organisation Costs	Managing resistance of change	Seminars, workshops, group discussions	Medium
		Reorganisation of the curriculum	Staff and academic consultant time	Low
		Restructuring of the organisation	Consultancy and staff time	Medium
		Business process reengineering	3rd party and consultancy	Medium

Table 5.15: Classification of *MAMEDCO*'s OSELA adoption costs

5.3.10 Support

The OSS phenomenon is in its infancy in the Egyptian IT society in general and in Higher education in particular. The availability of support and maintenance is found to be an influential factor in the adoption of OSELA in *MAMEDCO*. *MAMEDCO* used to rely on internal staff and third parties to provide support and maintenance and they know how this is affecting the functionality of the software and sustainability of the service. *MAMEDCO* believes that support is to be available in the market and should not be a barrier for adoption. The vice dean explained:

> *"For the last decade, many grants were available from the government to prepare youth and train them in the IT domain. Egypt now has a large capacity for youth that have been trained to pursuit an IT career. We have numerous IT Small and Medium*

Sized Enterprises (SMEs) that outsource to large companies both locally and regionally. Moreover, the IT outsourcing has reached many large market like USA and Europe and had been adopted in the government economical plans for the next decade. All these indicators provide confidence in the availability of technical support in the country. However, we still need to re-direct this labour force to be more oriented to the OSS (which we believe should be an easy task) and encourage them to establish official SMEs that provide support and maintenance to the HEI"

5.3.11 External Pressure

As for all medical schools in Egypt, the demand has always been high from students to enroll and *MAMEDCO* had no direct competitors as all enrollments are centralised through the admission system in the Ministry of Higher Education (MOHE). However, since the inauguration of the international programme, *MAMEDCO* was in competition with other colleges in Egypt offering the same programme and also with other medical colleges all around the world. This new competitive environment put pressure on *MAMEDCO* to attract students and to retain them *(Dean of MAMEDCO)*

On the other hand, the MOHE new policies and regulations for education reform had put extra pressure on the management of *MAMEDCO* to join QAAP initiatives. At this point *MAMEDCO* had been involved in further competition with participating colleges to prove success.

5.3.12 IT Sophistication

For many years *MAMEDCO* was known for its sophisticated use of technology in education. When interviewees were asked for reasons, the head of e-learning unit explained:

"MAMEDCO has recognised the importance of technology in education for some time. Since the beginning of the century we had established a good IT department to fulfill our staff and students requirements. Since that time many projects have been launched to enhance the way our users use technology in teaching and learning. Moreover, numerous systems have been implemented in our university hospitals to improve the healthcare system"

Eventually the availability of skillful IT staff could boost the implementation of OSS and obtain the most benefits from contacting OSS community and support online. Moreover, staff are capable of solving problem internally with the source code available and to work with interoperable and customisable applications. On other hand IT sophistication had influenced the decision to adopt OSELA.

5.3.13 ICT infrastructure

For many years, *MAMDECO* did not have any ICT infrastructure. The teaching environment in medical schools did not recognise the intensive role of IT in medical education. Since its establishment, the traditional way of teaching medical studies was the dominant method. There was a lack of knowledge of the potential benefits that can be generated from the use of information systems and technology in the medical education *(Local Director of QAAP).* The administration and the management of the faculty still operate totally on paper with no dependency on any computational system what so ever.

Nowadays, as specific funds are only available to the enhancement of the ICT infrastructure - mainly from the QAAP- more concern is given to the importance of ICT infrastructure and the needs for information systems. In the earlier stages, *MAMDECO* used shared facilities with the University main ICT department to install and host several custom made e-learning applications. *MAMEDCO* used to pay for the hosting server and it was the responsibility of the University ICT team to maintain and support.

Chapter 6

Case Study Analysis & Discussion

Chapter 6. CASE STUDY ANALYSIS

The literature presented in chapters 2 and 3 has emphasised the lack of theoretical and conceptual models for the adoption of Open Source E-Learning Application (OSELA) in HEI. There was a general demand for theories that enable researchers to better analyse, explore and understand existing and emerging OSS technology adoption in HEI for e-learning programmes. The author attempts to address this gap in the literature by proposing a novel conceptual model for the adoption and evaluation of OSELA, therefore, contributing towards a better understanding of factors influencing the adoption in OSELA in HEI. The model was empirically assessed in chapter 5. The aim of this chapter is to consider the empirical data derived from the case studies and provide revision to the conceptual model proposed in chapter 3. Hence, the chapter propose an empirically tested novel conceptual model for the adoption and evaluation of OSELA in HEI. This model is to be used by HEI as a tool to assist management in their decision making process.

6.1 ENVIRONMENT

The interviewees from the e-learning project team in *ALDENCO* have reported that user acceptance and involvement are more difficult than expected. Though teachers and students were good technology users, both parties lacked the concept behind using technology for learning purposes. The environmental conditions are critical to the deployment and the intended business outcomes from using the software are delayed due to the non readiness of the stakeholders.

Today's web ready students with their expectations for college and university IT services to be on the same level of web services offerings (e.g. unlimited storage for e-mail, videos and files, and social interactivities among students and between students and teachers). These expectations raised the pressure on the managers in all three cases to procure and select the e-learning platform that are mostly likely to meet students' expectations and that ensures student retention and interactivity.

For the three studied cases, the IT infrastructure was poor and the IT skills available were not sufficient to maintain the e-learning platform. The surrounding highly competitive IT market and the low governmental salary policy have caused lack of talented and skilful IT staff in medical colleges in Egypt. This is due to many factors, including: (1) noticeably low salaries in public colleges (around one tenth of salaries of same positions in commercial sector), (2) limited financial resources directed to ICT infrastructure, and (3) lack of talented open source developer in the market (due to low salaries. Most of the highly skilled personal migrate to higher economical countries). For those reasons, both *ALDENCO* and *ALMEDCO* have chosen to host their e-learning systems on commercial hosting service providers that also provide support and periodical maintenance (see sections 5.1.14 and 5.2.14).

During discussion and interviews with *ALDENCO*, the author noticed confusion surrounding a complete understanding for the open source movement. For some, it was mixed with freeware concept. One interview stated "*open source is having software for free, without paying fees for Licence*". Understanding the full capabilities of using the

code and contribution to the global movement was not clear. There is a need to enhance the HEI professional level of knowledge on IT in general and the use of technology in learning in specific. Most of the interviewees were more knowledgeable with software vendor that came first to their doors. Even when selecting OSS, they usually choose depending on early adopter in their field. They donot have sufficient resources to compare and assess different technologies and different application within same line of technology.

6.2 ORGANISATION

From empirical data derived from cases in chapter 5, it is becoming clear that E-learning is more than deploying a technology; it is changing the core business of an educational institute that has been there since its establishment. The institution capacity, its interest in applying the e-learning applications and its staffing infrastructure is clear to be as important as evaluating the technological aspects. If the institution staffs are not totally aware of its business processes and the effect of inducting technology to increase teaching and learning capabilities, it does not matter which technology to use, in either case, deployment, support and effective use of the product will be difficult. This confirms that assessing an institution's capacity and its staffing infrastructure is as important as assessing the technical infrastructure.

In an institution that is characterised by limited knowledge in the e-learning area, unclear structure of business process and architecture, poor IT infrastructure and staff with limited online teaching skills, the flexibility of the software and technology applied can make or break the whole initiative. The deployment of OSELA is reported to have more success than using a turnkey solution where a sense that with a bit of money to invest all problems will be solved. The OSELA adoption decision gave the management in *ALMEDCO* the opportunity to plan and act. The plan for institution-wide OSELA started with a pilot project, during the deployment of OSELA feedbacks and remarks were collected from different stakeholders about the usage of the system, corrective actions were made to the main plan and new application was deployed locally and integrated with the system. This action plan would not be possible in a closed system.

Inducting new educational technologies to improve learning and enhance the quality of education affects teaching workload on teachers. Instead of being leveraged to think of improvements and plan for enhancements in their courses, teachers found themselves overburdened by spending more time on learning aspects and concepts of quality, more time in attending workshops and seminars. They had to learn new technologies which were not easy for many of them to understand how those technologies will affect the quality of teaching and deliver better learning opportunities to learners. It is difficult, therefore, to achieve any improvement via e-learning without rethinking teaching and learning approaches and techniques.

For *ALMEDCO* and *MAMEDCO* both had recruited a skilful IT team to be in support of the implementation and deployment of OSELA. Yet, they both have to rely on external support. *ALMEDCO* hired an external consultant, while *MAMEDCO* relied on the available highly experienced staff at the university level. On the other hand, *ALDENCO* relied on an external support deal to deploy OSELA, and recruited a non technical support team to support the staff and students. The case studies confirm that the availability of human capital (knowledge, skill, abilities, and experience) within the organisation and access to human capital outside the organisation has been found to influence their decision to adopt OSS. These findings concur by the results found in (Koohang and Harman 2005, Fry *et al.* 2009) study.

Moreover, the empirical data have shown that the size and scope of the institution affects the decision to adopt technology. The large size of *ALMEDCO* and *MAMEDCO* and relatively large size of *ALDENCO* was a primary factor in the non adoption decision of proprietary software. In the same context, the scope of HEI to implement a campus wide e-learning system with numerous interoperable applications led to favor OSS to proprietary software. These empirical findings are supported by literature (Armbrust *et al.* 2010). Therefore, modifications are made to the conceptual model proposed in chapter four (see figure 3.1) to add these factors (see section 6.5).

6.3 TECHNOLOGY

The flexibility and trialability (the ability to be tried out) of open source software gave both *ALMEDCO* and *ALDENCO* the opportunity to decide to start with a pilot project while still planning for a fully integrated institution-wide OSELA. This opportunity allowed live testing and examining for environmental conditions and allowed decisions about how to use and integrate the application to be made during deployment.

In two cases, *ALMEDCO* and *ALDENCO*, they have not had legacy information systems. This non existence of any commercial, developed locally applications or legacy information systems was a point of strength instead of being a weak point. The absence of those systems eliminated any extra cost for application integration software or interoperability costs to migrate or switch to OSELA.

The advantage of the availability of code offered by OSS was of no use in *ALDENCO* and *MAMEDCO* cases, as the main concern was to use the pedagogical feature available in OSLMS and to spread the use of technology in teaching and learning. Meanwhile, the OSLMS was mature enough not to need any special knowledge for the code to be deployed or to know how to use the software. This is consistent with the studies of Miles and Huberman (1994) that questioned the importance of code availability if no one uses it, and comply with the study of Li, *et al.* (2005) who noted that typical users are not interested in the availability of source code; they are more concerned with the software's usability. However, the availability of code and ability to access the code in the future if needed gave the e-learning project's managers confident and trust in the software.

In contrast, *ALMEDCO* considered the availability of the source code to be an advantage as they had to access the code in order to integrate various applications together. Moreover, the ability to test several applications freely before taking the decision to adopt them would not be an option without having the OSS model. *ALMEDCO* was able to deploy a test environment where academics, technicians and administrators could test any applications and review it before officially adding it to the

platform. Free downloads and freedom from licensing restrictions enhanced the trial ability of OSS, which was found to enhance its adoption. These finding supported many studies as they believe that OSS will provide both academics and technologists supporting them flexibility to maintain the balance between technology and pedagogy (Li, *et al.* 2005, Weber 2004).

The transition from custom made application to open source software become possible when MAMDECO could take advantage of the economies of scale offered by Open Source Software that offered a combination of low cost, acceptable control and the possibility of innovation and scalability.

From evidence in chapter 6 in the evaluation of OSELA (see section 5.3.5), most of the *MAMEDCO* interviewees rated OSS infrastructure medium to Low. The author found some indicators to explain these choices:

1. *MAMEDCO* had just migrated from home grown application to use OSLMS following the recommendations from other colleges in their university and not based on internal search and evaluation. Thus, most of the interviewees had limited knowledge on the OSS movement and OS popular applications.
2. *MAMEDCO* was working for a long time with specific proprietary company to provide them infrastructure software, and did not have the chance to work with OS infrastructure software. Thus, they did not have the opportunity to test the performance of OSELA on OS infrastructure.

6.4 LEARNING FROM CASE STUDIES

Many parameters have been extracted from the empirical data presented in the preceding chapter and have been identified as factors. The following section summarises the key issues that were extracted from the analysis of the case studies:

- The E-learning concept is totally new in Egypt, and the resistance to its deployment is higher in practical colleges, especially medical colleges. At the

same time, the induction of open source as a free "gratis" solution, made the linkage strong between e-learning and open source. For almost all interviews, open source became the metaphor of e-learning. Thus, there is a mix between the two concepts and most of the time; when asked about open source; interviewees discussed factors that are specific to e-learning without being able to distinguish the difference between two topics. This coupling made the investigation and the exploration of cases more complex. These finding are aligned with the study conducted by (Chang *et al.* 2005, Chong *et al.* 2009, Dedrick and West 2003, Zhu and Kraemer 2005) that explored open source as a metaphor for e-learning.

- The cases presented in chapter 6 revealed that these institutions selected to use OSELA mainly for the cost factor. Cost was the primary factor that positively influenced the decision of OSELA adoption. Moreover, the cases reported that the use of proprietary software in the Egyptian higher education environment (large number of students, limited financial resources, scarce in IT skilful staff) is hardly possible. They indicated that the implementation of e-learning in the country is only possible through OSELA. This finding is supported by literature (Fitzgerald and Kenny 2003, Larsen *et al.* 2004, Dedrick and West 2003) that considers the cost as the primary factor for HEI to adopt OSELA.
- On the contrary, the lack of an evaluation framework to assist institutions in evaluating different applications negatively influenced the adoption decision. Both the lack of evaluation framework increased the risk since institutions were lacking necessary knowledge on the process and procedures of OSELA adoption and evaluation.
- Although all cases reported the importance of the proposed OSELA evaluation framework in selecting the most suitable application to be incorporated in the integrated learning platform, they also reported the need for a framework that evaluates OSELA packages. This framework is important to identify the features that should be available in each package, how to use them in higher education domain and how to evaluate those features.
- Only *ALMEDCO* took the decision to develop and use individual framework to evaluate the OSLMS packages before the implementation of the pilot project. *ALMEDCO* has developed it evaluation framework based only on pedagogical

aspects. The framework was used to compare between different OSLMS' features and functionality.

- The cases studied provided enough data to be able to estimate the areas of low, medium and high cost. These empirical data when used for the aim of OSELA adoption is expected to increase cost analysis, allow better understanding of cost factors, and support better decision making.
- *ALDENCO* and *MAMEDCO* took advantage of the success story and lesson learned from a previous OSELA adopter. This conforms to Olla (2007) study that noticed that OSS applications are often selected based on familiarity or recommendations by colleagues and research done by (Lundell *et al.* 2006, Morgan and Finnegan 2007, Williams and Eyo 2010) that explored the importance of evidence of success particularly for institutions transitioning from commercial systems to OSELA.
- Moreover, it is most likely that decision makers do not use evaluation and selection procedures, due to the difficulty to choose a suitable evaluation method as a result of lack of clarity of the OSS evaluation methods landscape (Morgan and Finnegan 2007). With The technologies were well adapted to achieving economies of scale. Thus HEI should aim to take advantage of early adopters by integrating success stories, lessons learned, and OSELA itself across as many institutions as possible.
- Initially, the use of technologies for three cases was based on the availability of some motivators in each case and not on strategic plans. In each case, there was a champion who initiated this movement, and afterward was the person in charge. The author found the decision of institution to be affected by level of knowledge this person had. However, the establishment of IT and e-learning units made a larger and more knowledgeable group able to discuss issues from different views and perceptions.
- The empirical data have shown that the cost of OSELA is considered to be very low in comparison with proprietary software. But the total cost of ownership that is associated all along the implementation of e-learning should be calculated and budgeted. The beliefs of HEI that OSS is free or even require minimal costs for training, maintenance and support could be deceptive. The total cost of the whole e-learning implementation could be higher than certain HEI estimations.

These costs are factors in the size of the HEI (number of staff, academics and students), objectives required from e-learning implementation, institution's readiness (infrastructure, IT sophistication, curriculum adaptability, staff motivation, etc.), availability and cost of 3rd party support. With regard to technicality, there are many factors that should be considered that have direct effects to cost like: size of the required OSELA (number of applications needed) to attain institution's objectives and goals, integration and interoperation costs, costs for branding, customisation and Localisation. Thus, it is very important to plan rationally for all activities involved in OSELA implementation to avoid any unforeseen costs that could cause the termination or failure of the deployment.

6.5 THE REVISED CONCEPTUAL MODEL OF OSELA ADOPTION

The preceding chapter provided much empirical data that is to be used to assess the conceptual model proposed in section (3.1) for the adoption of OSELA. The data resulted from the analysis of the case studies reported the need to revise the conceptual model and suggested some modifications.

6.5.1 Cost

The cases studied in chapter 5 have reported that the primary factor that influenced the adoption of OSELA was the cost. At the beginning the term 'free software' was misleading and institutions estimated zero cost. The deployment of the pilot project indicated a considerable cost related mostly to human costs (maintenance, support, customisation, and consultancy) and organisational costs (recruiting skilful IT staff, IT infrastructure and employee training). These findings are in accordance with literature which identified the cost as the most important metric for making OSELA adoption decision (Koohang and Harman 2005) and supports that even with the absence of cost related to OSS acquisition, there should be a cost associated with the deployment and implementation of OSELA (van Rooij 2011).

6.5.2 Benefits

A Higher Education Institution's decision to use e-learning methods to improve its functionality and learning process led it to assess the benefits of different technologies. For all of the cases reported in this study, the decision to adopt e-learning was coupled with the decision to choose the technology. Thus, variety of evaluation criteria was shared between both e-learning and OSS concepts, and therefore, the distinguishing between benefits of each was sometimes hardly possible. Eventually, institutions took into consideration various factors prior the decision to adopt OSELA. The benefits of OSELA were assessed versus the benefits of selecting proprietary software and in accordance with the benefits promised by e-learning. Institutes under investigation favoured OSELA to proprietary software for expected benefits such as: lower cost, better control, and support. Thus, benefits are considered to be an influential factor in the adoption of OSELA in HEI. These findings are supported by the literature that reported that HE institutions assess all types of benefits (e.g. financial, operational, managerial, and technical) that OSS offer before deciding to adopt them (Hauge, *et al.* 2009).

6.5.3 Barriers

The data revealed from the case studies reported that the induction of technology in education had made HEI assess their current capacities and to identify possible barriers to the adoption. Clearly, the poor IT infrastructure, limited budget, low skilful IT staff and the resistance to change within staff were among other factors that formed a barrier to e-learning and any associated technology. While the limited budget was the primary barrier to the decision of non adoption of proprietary software, the other barriers seem to be possible to overcome with OSELA. It appears from the empirical evidences identified in chapter 6 that institutions consider deployment barriers prior proceeding with the adoption of technology. These findings were supported by studies that identified barriers to influence OSS adoption for e-learning implementation in higher education (Sclater 2008).

6.5.4 External pressures

HEI in Egypt are under pressure to provide best value for money services and have performance credibility within very strict budgetary boundaries. The external pressure to adopt and implement OSELA on the case studies reported in chapter 6 can be summarised in the following:

1. Local medical colleges participating in QAAP project,
2. Local medical colleges offering e-learning programmes,
3. International medical colleges offering online postgraduate studies to local students, and
4. Time limit to implement e-learning programmes and the audit and assessment from the QAAP board of directors.

The empirical findings have shown that external pressure is a factor that affects the adoption of OSELA.

6.5.5 Support

Empirical data have provided insight into how many types of support are used by HEI. All institutions in this study relied on OSS community support as the main support channel. This indicates that the absence of commercial support should not be a barrier to the adoption of OSS. Both *ALMEDCO* and *MAMEDCO* relied also on their internal knowledge and staff skills. Hence, the value of internal support and most importantly the support provided by the OSS community should not be underestimated. On the contrary, *ALDENCO* decided to depend on commercial support due to the absence of technical expertise on their premises. This use of commercial support may change over time when internal support becomes available. These findings are in accordance with literature studies such as Stol and Ali Babar (2010) that recommend the balanced mix of external support that fulfils the needs of HEI and that is aligned with the knowledge available within the institution.

6.5.6 The level of IT sophistication

This factor refers to the technical personal available in the institution. It is related to the level of understanding of different kind of technologies, the ability to work with innovative solutions effectively, and the availability of skills (both technical and managerial) to address implementation problems at any institute. The study of the cases presented in chapter 6 has shown that the level of IT sophistication has affected the adoption of OSELA. All cases lacked skilled personnel knowledgeable in the area of OSS. Still both *ALMEDCO* and *MAMEDCO* had benefited from technical staff with good technological background to build on them their support. These findings are in line with strong recognition in the literature to the skills of staff members as critical factor to adoption decision (van Rooij, 2011). Though the lack of technical staff at *ALDENCO* was a problem, it did not affect the decision to adopt OSELA. Meanwhile, both *ALMEDCO* and *ALDENCO* hired an external consultant to improve the level of IT sophistication. The collaboration between the internal staff (case of *ALMEDCO*) or the external 3rd party support (case of *ALDENCO*) with the consultant influenced positively the level of IT sophistication in both institutes.

6.5.7 IT infrastructure

As reported in the case studies, all of the cases suffered from poor IT infrastructure. This poor infrastructure was an influential factor in the decision of not adopting proprietary software. For OSELA, the ability to be deployed on the cloud and the use of SAAS has driven both *MAMEDCO* and *ALDENCO* to the rapid deployment of the OSLMS. Eventually issues related to privacy and confidentiality are considered and are still under further investigations. But from the technical view, recent technology and OSS flexibility have made the deployment in OSELA in a poor IT infrastructure possible and reliable, as emerged from the empirical findings.

6.5.8 Internal pressure

The empirical data have shown that internal pressure is a factor that influences the decision to adopt OSELA. The internal factor as reported in the case studies include among others the following:

1. The colleges management needed to have a more controllable and manageable method to control the quality of education delivered online individually and voluntarily by professors.
2. Today's 'digital ready' students have high expectations for what campus IT services should provide. The main challenge faced by all cases was that students usually benchmark colleges and universities' IT services with other public services free offerings
3. Staff member willing to use online resources and electronic library for their research and teaching and calling for a unified electronic system.
4. Confusion surrounding the use of the most suitable technology and systems that is aligned with the pedagogical objectives.
5. Large number of students and staff members with limited budget.

The last factor was not initially included in the adoption model proposed in section (3.5) but it emerged from discussion with interviewees as reported from cases studied in chapter 5. The suggested modification and the empirical evidence were taken into consideration by the author, and modification to the adoption model was implemented as shown in figure (6.1).

The main findings derived from the study presented in this dissertation are presented below:

- A review of literature has revealed an absence of theoretical models that describe the adoption of OSS in e-learning by HEI. This is justified by many researchers due to the infancy of OSS research.
- More investigation in the adoption literature resulted that there is certain confusion surrounding the area of OSS adoption in e-learning. E-learning is often conceived as single application which is LMS. However, the market is filled with a variety of other applications. Meanwhile, the HEIs' need to have an integrated learning environment that serves both academic and administrative needs, and create a balance between sound pedagogy and business efficiency has resulted in more confusion

surrounding the selection and evaluation of OSS e-learning application (OSELA).

- This gap in research has led the author to attempt to fill the gap in the literature by proposing a novel conceptual model for the adoption and evaluation of OSELA. The conceptual model has been empirically verified through three case studies. The empirical evidence indicates that the use of the proposed framework increase IT sophistication and can be used as a tool for decision making to support HEI.
- It is not the author's intention in this dissertation to offer prescriptive guidelines to OSELA adoption and evaluation but rather, describe case study perspectives that allow others to relate their experiences to those reported. Hence, this dissertation offers a broader understanding of the phenomenon of OSELA adoption.

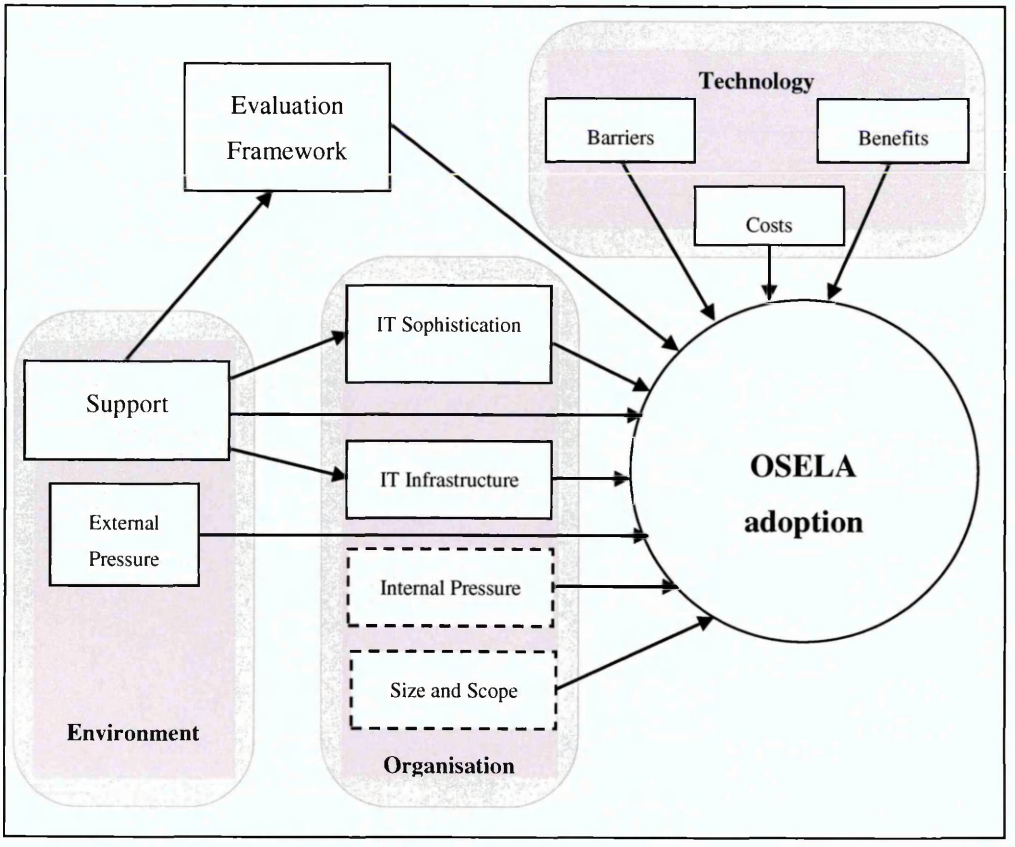

Figure 6.1: The revised Conceptual Model for OSELA Adoption in HEI based on TOE framework

6.6 THE REVISED EVALUATION FRAMEWORK

Empirical evidence reported in chapter 5 indicated that the availability of an evaluation framework is essential to assist decision makers for evaluating and selecting OSELA. The evaluation framework will give insights to HEI not only to estimate costs, but also to estimate complexity of the project and its time plan. The conceptual framework for the evaluation of OSELA proposed in section (3.4) was assessed during the case studies with interviewees. The majority of interviewees expressed their satisfaction from the use of the proposed evaluation framework. They found it helpful in evaluating different available applications, eliminated much of the confusion surrounding the use of OSS for e-learning purposes, and most of all gave them the chance to decide what applications must be incorporated in their integrated e-learning environment. They have also emphasised on the influence of the framework on decision for OSELA adoption.

Meanwhile, the proposed framework required minor modifications. *ALMEDCO* interviewees proposed to separate between the office systems and the web browser. They argued the use of different office systems does not affect users experiencing the OSELA and it does not interoperate with the e-learning applications. On the contrary, the use of open source web browser proved to be efficient in dealing with different OSELAs and it directly affected the functionality of various applications. This argument was discussed and supported by the other two cases. This empirical evidence reported that proprietary browser limit the functionality of OSS; especially LMSs are not supported by literature. To the author's best knowledge to research has studied the effect of proprietary browser on the functionality of LMS. Thus, the author raises a need to investigate and study the role of web browser on user's accessibility to LMSs.

Moreover, all cases rated the importance of evaluating office system to be very low. The majority of interviewees indicated that the use of office systems (either proprietary or open source) is not related to the set of required e-learning applications. In the same context, almost all LMSs are compatible with both types of systems, and the use of either of them does not limit application functionality. The suggested modification and the empirical evidence were taken into consideration by the author, and modifications to the evaluation framework were implemented as in table (6.1).

		Applications Requirements											Application Purpose			e-learning mode		
Category	**Applications sub category**	IT and Web profile	Customisability	Interoperability	Functionality	Security	Documentation	Support	Licence	Longevity	Community	Maturity	Industrial Focused	Education Focused	General	Blended e-learning	Online Blended e-learning	Self Based e- Learning
Learning	Learning management system																	
	e-Library Systems																	
	Social Learning Systems																	
	Portfolio Management Systems																	
Supportive	Research Administration																	
	Conferences Management																	
	Journal Administration Systems																	
	Portal Administration Systems																	
	Web Browsers																	
Business	Student Information System																	
	Facility and Class Management																	
	Financial Management																	
	Human Resources Management																	
Infrastructure	Operating Systems																	
	Identity Management System																	
	Web Servers																	
	Database Servers																	
	Unified Communication Systems																	

Table 6.1: The revised Evaluation Framework for the selection of Open Source E-Learning Applications

Chapter 7

Conclusions and future research

Chapter 7. CONCLUSIONS AND FUTURE RESEARCH

The purpose of this final chapter is twofold: (a) to conclude the research of this study which has conceptually and empirically identified factors that influence the adoption of OSS in e-learning implementation by higher education institutes, and (b) to propose area for future research. The chapter begins by presenting a thesis review in section (7.2). Thereafter, the novel research contributions are summarised in section 7.3. The chapter ends with research limitations (see section 7.4) and suggestions for future work in the area of OSELA (see section 7.5).

7.1 THESIS REVIEW

The dissertation started with a review of the research context in the area of OSS adoption for e-learning by higher education institutes. It began by identifying e-learning as a new way for teaching and learning in higher education. Then it was argued that proprietary software has major limitations to HEI need of technology for learning. The use of Proprietary Software proved to be non cost effective and complex to interoperate.

These limitations had led HEI to seek alternative technologies that are more cost effective, more flexible and interoperable. In this context, OSS has been proposed as a technology to effectively be used for e-learning in HEI. The chapter then explored HEI' need to have an integrated learning environment that serve both academic and administrative needs, and create a balance between sound pedagogy and business efficiency. This integrated environment was discussed through the introducing of Open Source E-Learning Application (OSELA). Following, it was argued that while OSS is still an emerging research area, there is a need to extend the research to explore the adoption of OSELA by HEI. Thus, this argument has led to focus on research problem, leading to the objective and aim of this research which is *Evaluate the adoption of Open Source E-Learning Application (OSELA) in Higher Education Institutes in developing countries.* Then, a thesis structure was presented briefly introducing the objectives of the subsequent chapters to provide a general overview to the dissertation outline to the reader.

In an attempt to meet the aim of this dissertation, chapter 2 (background theory) started with a review on the motivations to OSS adoption in HEI. More investigation and analysis of relevant literature were conducted to identify factors and understand their influence on the adoption of OSS by HEI. In reviewing OSELA motivations, barriers benefits, opportunities, and challenges, an important research issue has emerged. The author argues that there is a technological confusion surrounding the use of OSS in e-learning and there is a lack of a common framework for evaluating and exploring the adoption of OSELA.

Chapter 3 (focal theory) has focused on addressing the need to develop a conceptual model that supports a common understanding of OSS adoption for e-learning implementation by HEI. Because research on OSS adoption is still in its infancy and the absence of theoretical models that deal with OSELA adoption, the author has drawn knowledge from other area of ICT adoption. Using this approach, the author was able to develop a robust theoretical model for exploring and explaining the adoption of OSELA. The framework considered factors that influence the adoption and usage of the innovation, which is rooted in the specific technological, organisational, and

environmental contexts of an organisation. Thereafter, a novel evaluation framework has been proposed (table 3.4) to reduce the confusion surrounding the use of OSS in e-learning and to support the selection of appropriate applications.

Since there is much confusion on the use of OSS in education for learning and teaching, the author critically evaluated OSS applications, their functionality and their use in various learning processes. In support of this evaluation, a novel taxonomy for classifying types of OSS applications for integrated e-learning environment is proposed. This taxonomy enhances IT sophistication as it allows both researchers and decision makers to capture the whole range of OSS applications and their functionality in education.

To undertake the research that focuses on the issues identified in chapters 2 and 3, an empirical research methodology that establish the nature and scope of the empirical inquiry is presented in chapter 4 (data theory). The chapter begin with discussing the research epistemology and then justifying the selection of interpretivist stance. The selection of interpretivist stance led to the selection of qualitative research mode which is also consistent with the research question and the. The requirement for exploration of multiple settings justified the selection of multiple case study strategy. Then, the use of interviews was argued to be the most suitable and effective data source for the qualitative research.

Following the development of research methodology reported in chapter 4, chapter 5 (data theory) then presented and analysed empirical evidences. It presented the analysis of qualitative data, leading to the identification of empirical factors influencing the adoption of OSELA by three medical HEI. The evidence derived from the case studies confirmed many of the issues identified in chapters 2 and 3. In addition, empirical evidence has suggested a number of modifications for the conceptual model and the proposed evaluation framework. These findings have been considered in chapter 6 (novel contribution) and resulted in the revision of both the conceptual model and the evaluation framework.

7.2 RESEARCH CONTRIBUTIONS

There are three novel contributions to research and practice in the areas of OSS adoption and general IT adoption arising from this research. The contributions are: (a) novel model for OSELA adoption and evaluation, (b) novel framework for evaluating OSELA, and (c) novel taxonomy for classifying types of OSELA. These contributions are summarised and discussed in the following sub-sections.

7.2.1 Novel model for OSELA adoption and evaluation

The main contribution of this dissertation is the development of a novel model for OSELA adoption and evaluation (see Figure 6.1). As described earlier, OSS adoption research is still in its infancy and there is a lack of a proven model describing OSELA adoption. Also, research on OSS adoption by HEI for integrated e-learning environment especially in developing countries has been ignored and there has been little or no focus to this research gap. In addressing this void in literature, this novel contribution fills the knowledge gap in the emerging research area of OSS adoption and the IS field in general.

The conceptual model is proposed in section (3.4), empirically investigated and analysed in chapter 6, and revised through empirical evidences derived from case studies. The final model for OSELA adoption is presented in chapter 6 (see figure 6.1). The model makes novel contribution for both researchers and practitioners. The model incorporates factors that identified in previous IS adoption studies, extents these works and adapts them to OSS e-learning area, and also incorporates factors derived from empirical evidences resulting in the development of a consistent model for OSELA adoption and evaluation.

7.2.2 Novel framework for evaluating OSELA

The second contribution deals with the proposition of a novel evaluation framework which supports the assessment of open source e-learning applications. This framework is produced to clarify the ambiguity and confusion surrounding OSS adoption for e-learning by HEI. This framework has been proposed in chapter 3, assessed by case studies in chapter 5, and revised and confirmed in chapter 6.

The evaluation framework is based on criteria that are derived from a comprehensive literature review and analysis. In addition, empirical evidence has indicated revisions to the framework. The revision of the framework incorporated the additional criteria that derived from the empirical case studies (see table 6.1). The framework is to be used as a frame of references to highlight possible combinations of OSS applications that can support the integrated e-learning environment in HEI. The framework could also be used as a tool to support decision makers and technical managers in selecting the most appropriate combination of applications that will interoperate to achieve both academic and business goals of HEI.

7.2.3 Novel taxonomy for classifying types of OSELA

The third contribution from this study deals with the proposition of a novel taxonomy for classifying types of OSELA. In chapter four, the author drew on critical review and analysis of normative literature on open source software in higher education. The novelty of the taxonomy focuses on the combination of a comprehensive set of applications that describe the higher education requirements for e-learning implementation. Since there is an absence of classification of OSELA, the author attempts by this novel taxonomy to expand the knowledge on OSELA types and eliminated ambiguity surrounding the selection of OSS in higher education. The proposed taxonomy support research and practitioners to better understand the OSELA and therefore, it will allow decision makers and implementers to better select and implement OSS e-learning, thus it can be used as a tool for decision making.

7.3 RECOMMENDATIONS FOR FUTURE WORK

The author suggests a confirmatory research study to validate the adoption model developed in this study using a large scale survey questionnaire, rather than continuing with an interpretivist epistemology. This large scale survey will offer the opportunity to establish generic significance to the evaluation criteria and factors related to the proposed model and framework. In addition, the confirmatory study could also address the issues of bias in the case studies and participants in this study.

Another research proposition is to establish whether the model can be use by private universities or is only valid with public universities. As discussed earlier, the nature of public universities (large number of students, scarce resources, and limited budget) has derived the non adoption of proprietary software and favoring OSELA adoption. Therefore, an interesting area for further research could be to investigate the adoption of OSELA by private universities.

It will be important to study and test inter-systems integration between different types of applications and commercial products in order to get the most robust OSELA. In addition, it is important to test and measure OSELA validity in different educational domains.

Another recommendation is to study the factors that influence the adoption of OSELA. Such a study should investigate each factor individually and classify factors depending on their importance and the level of influence.

There is a dearth of research literature on the adoption and non adoption of OSS for e-learning in HEI. Even the numerous studies in OSS adoption in general, was limited to the primary adoption (the initial decision to adopt at the organisational level) with almost a very few studies reported the second adoption (the actual implementation process which involves adoption by individuals throughout the organisation). A final recommendation is to study the second adoption for integrated open source e-learning applications in HEI especially in the developing countries.

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APPENDIX I – EGYPTIAN EDUCATIONAL SYSTEMS

The aim of this appendix is to present the higher education context in Egypt, outlines the e-learning implementation in Egyptian higher education to date, and discusses the challenges of, and prospects for, further integration of e-learning in higher education in Egypt.

EGYPTIAN EDUCATIONAL SYSTEM

There are two parallel education systems prevailing in Egypt; the secular system and the religious, or Al-Azhar system. The secular system is organised as follows:

a) The first level, known as *basic education,* covers the first nine years of schooling (6 years is known as primary school and 3 as preparatory school) starting at the age of six.
b) The second level divides students between three-year general academic *secondary schools* and three or five-year vocational schools.
c) The third level is the *higher education* level.

Al Azhar University is considered one of the world's oldest surviving degree-granting institute. It was founded by the Fatimid dynasty of Egypt, in the year 970. It served as a centre for Arabic literature, Sunni Islamic learning and centre of higher learning (Bearman 1989). The transition to an actual university took place in the 1950s, with the introduction of faculties in Islamic law and jurisprudence, Arabic grammar, Islamic astronomy, Islamic philosophy, and logic (Berkey 2007). In the 1960s many modern secular faculties were added, such as medicine, engineering and agriculture. Still for all secular faculties, Islamic and Arabic studies form a major part in the curriculum.

The main difference between the Al-Azhar higher education system and the secular university system is in enrolment and admissions. Students who graduated from Azhar

schools are most likely to follow their higher education in Azhar University. While students graduating from the secular school system are admitted in secular universities, based on the results of the Secondary Leaving Examination Certificate that is highly competitive. Students are allocated to faculties in public universities according to the levels they attained in their Secondary Leaving Examination Certificate. The Placement Bureau of the Ministry of Higher Education controls university admissions in a process called (Tansik).

With regard to Higher education secular system in Egypt, it can be put into categories; the public sector, comprising of public universities and high institutes, which is dominant and large in terms of number of students and academic staff (MOHE 2011), and the private sector mainly comprised of private universities which is small in term of numbers of students and academic staff. The system in 2010 is made up of 19 public universities (including the Azhar University), 52 public high institutes, and 19 private universities. Among the 82 high institutes, 47 are two-years middle technical institutes (MTI), and 35 are four or five-year higher technical institutes (MOHE 2011). Egypt has one of the largest higher education systems in the developing world in terms of the number of students, 2.73 million students in 2010, with approximately 32 percent of the 18-22 age groups enrolled in higher education. The overwhelming majority (around 92 percent) of all students attended public institutions (universities and higher institutes) whereas the rest attended private universities (IDSC 2010).

In official discourse, education in Egypt is "free" from basic to higher education. The government provides the largest share of funding. While officially the state is responsible for financing higher education in Egypt, Egyptian students pay between 30 EGP and 150 EGP (5.2 and 26 USD) per year as a token tuition fee to government funded universities. Past years have witnessed some major cuts in the state funding. The state's share of higher education finance for universities was reduced to 85 percent of the universities' needs in 1994-1995, followed by another reduction to 65 percent in the year 2010 (MOF 2011) leaving the universities to generate the remaining 35 percent through various revenue diversification strategies (i.e. revenue from industry training, community courses, and the introduction of alternative high quality internationally paid

programmemes). The nominal tuition fees for alternative academic programmes in the commerce college, for example that are perceived to be of high quality, are still low (L.E. 1,700 around USD 294) in comparison with the same programmes offered in private universities charging a tuition fee of (L.E. 15,000 USD 2,586) for the same programme (Fahim and Sami 2010, El-Araby 2010).

EGYPTIAN HIGHER EDUCATION CHALLENGES

In past decades, the higher education system in Egypt witnessed a decrease in the quality of education. A number of previous and recent studies in Egypt (Akkari 2004, El Sebai 2006, El-Khouly 2007, El-Araby 2010, OECD 2010, Abdel-Hamid *et al.* 2008) emphasised the fact that the Egyptian higher education sector faced a number of challenges including: (a) outdated management and governance of the higher education system, (b) low quality and relevance at the university level; (c) limited governance of the professors duties, (d) low per-capita income in general and low professors' income, (e) insufficient classrooms and other facilities, and (f) limited fiscal sustainability of publicly financed enrolments. The problem of unsustainable financials is related to the large number in enrolments in higher education and the dramatic growth of the higher education student population (2.1 millions in 2003 to 2.73 millions in 2010) (EIP 2010).

From the beginning of the 21st century, factors that represent mega trends driving the developments in society and higher education could be identified. In her study on the Egyptian Higher Education sector, El Sebai (2006) identified factors impacting on higher education development, among which she mentioned: the continuous development of information and communication technologies (ICT), the continuous emergence of knowledge (information) based economy and society, increased economic role of higher education and increased global competition. These new factors also pose serious problems on the already decreasing quality aiming to face a world moving very fast toward globalisation and increased competitiveness.

EGYPTIAN HIGHER EDUCATION REFORM

Higher education reform started recently in Egypt. A strategy for education reform was established in 2000. The strategies main aim was to re-address the need by Egypt to develop quality education in public universities. Available funds from the World Bank in 2002 allowed the start of the Higher Education Enhancement Project (HEEP). The HEEP aims, through 6 main sub projects, to improve efficiency by the reform of governance and management of the higher education system, and improve the quality and relevance of university education (HEEP 2011). The six projects are: The Higher Education Enhancement Project Fund (HEEPF), Information and Communications Technology Project (ICTP), Egyptian Technical Colleges Project (ETCP), Faculty of Education Project (FEP), Faculty Leaders Development Project (FLDP), and Quality Accreditation and Assurance Project (QAAP). The QAAP aims to enhance the quality of education. One of its main objectives is to induce new techniques and technologies to the curriculum and management system of all participating colleges. It is through this project that funds are allocated to implement e-learning programmes in all participating colleges (QAAP 2011). As e-learning represented an emerging concern among sub-projects, the HEEP directories required special care to build-up efficient crews in that field (HEEP 2008).

E-LEARNING IN EGYPTIAN HIGHER EDUCATION SECTOR

The early introduction of the Internet in Egypt in 1996 was through the network of the Supreme Council of Education. Since that time many individual initiatives were implemented by teachers in higher education to use the Internet in the learning process. This varied through time from communicating with students via e-mail, creating social groups to hold discussions, and recently post materials through personal websites (El-Khouly 2007). In his study, Mohammad (2008) identified three reasons for the need to adopt and implement e-learning into the Egyptian universities, these are: 1) as a method for enabling previously eliminated students with disability and geographical barriers to gain access to higher education; 2) the growth of information technology as there is availability of advanced technical and technological facilities; and 3) increasing social demand for enrolment in higher education while non availability of physical spaces. Abdel-Wahab (2008) claims that e-learning is considered to be a means of alleviating

the conventional educational problems facing Egypt. He emphasised that e-learning could provide solutions to overcrowded classrooms and transportation problems.

As a nation, Egypt has just begun to engage with e-learning in its Higher Education sector by the launch of the QAAP. Despite that, e-learning implementation in public universities and colleges in Egypt are financed through the government, the management of e-learning adoption projects are left to the individual institution to prepare its own educational environment to engage in e-learning. Participating colleges started formalising the e-learning activities and building their official e-learning platforms depending on their needs, institutional vision, and this unique field of education (i.e. Medical, Engineering, Commercial, Agricultural, etc.) (MOHE 2011). Moreover, Ministry of Higher Education (MOHE) through the Supreme Council of Universities (SCU) has established the National E-learning Centre of Egypt (NELC). The NELC represents the advisory and supervisory role of e-learning implementation in the Egyptian Higher Education sector; it offers a wide range of services and support facilities for university staff members to begin engaging with e-learning activities (NELC 2011). The NELC promote the use of Open Source (OSLMS) Moodle as the virtual Learning environment, it includes several sections and provides various services for staff and content developers, such as: Instructional Design, Course Builder, Virtual Labs portal, Learning Style, Identification System, E-Courses Production Management System, Workshops and seminars, Open Source Educational Materials Resources, and Course Development Training Programmes.

There are still some issues which will act as barriers to e-learning and which should be addressed before the e-learning implementation process begins. Andersson and Grönlund (2009) identified 4 categories of different e-learning challenges for both developed and developing countries. Those challenges are: Course challenges related to content, design and delivery; Challenges related to characteristics of the individual; Student or teacher, Technological challenges and Contextual challenges related to organisational, cultural and societal. More specifically, Beckstrom *et al.* (2006) studied e-learning in Egypt and consider the infrastructures, e-content preparations, and

interested parties' acceptance amongst other factors to be the most important key success factors.

Recently, a study of assessment of e-learning in Egypt through the perceptions of Egyptian university students showed that the idea of using technology as a learning tool appeared to be unfamiliar. Though the majority of students in the study sample said they believed that there was a strong relationship between learning and technology, and a significant number of them had PCs and used them to access the Internet, still very few had used them to support their learning (El-Zayat and Fell 2007). In the same context, two surveys were conducted in two consecutive years for new students in a medical school; these indicated that more than 93% of students had daily access to computers, 87% used the internet at least once a week, but only 3% of them used the technology or the internet to learn (AFM 2008). It is obvious that this low rate in using technology in learning is due to the unavailability of e-learning activities in their school studies. Thus, the author argues that once students are directed to learning portals and web based educational materials, this percentage of (3%) will certainly increase.

On the contrary, with regards to staff, a recent survey reported that faculty at an Egyptian university had inadequate technical software-specific knowledge and skills, particularly with the latest information technology resources, web-based interaction tools, and authoring packages. Faculty demonstrated inadequate e-learning experience in terms of frequency of computer and technology use, formal training received, and real practice in e-learning (Sadik 2007).

E-LEARNING IN EGYPTIAN MEDICAL SECTOR

In Egypt, the medical sector of higher education includes five major specialities; medicine, pharmacy, dentistry, nursing, and physical therapy. Medical sector colleges have a prestigious outlook as applicants to the sector's colleges always have the highest marks amongst high school graduates. This renders the sector's colleges a target for the highest achieving students and these graduates also have an effect on healthcare, which is another important sector in the society. On the other hand, because most of graduates

of these colleges affect another important sector in the society which is healthcare, these colleges became the main target of the educational enhancement projects organised by the Egyptian government. The public secular higher education contains 49 colleges in which 116,326 students are enrolled, forming 79.7% of the total enrolled students in all three bodies of higher education (secular, religious, and private)(MOHE 2011) .

Besides the typical e-learning implementation problems of higher education in Egypt mentioned in previous sections, a number of other problems have emerged in the medical sector colleges (Abdel-Hamid *et al.* 2008). These problems can be summarised as follows:

1. There are a large number of students in practical based learning environment. Compared by other sectors in Egypt, medical sector student numbers are much smaller than other sector. However, due to the natural characteristics of medical studies that require practical work with small groups, the number of enrolled students is relatively large for the purpose and objectives of the medical education.
2. Lengthy educational programme: students in Medicine Colleges for example need to study for 6 years in addition to one practical year (total of 7 years) before they graduate. Moreover, before practising privately most graduate students need to pursue their master degrees in their speciality. This leaves the education system with students studying for a minimum of 10 years.
3. Most of the post graduate students are full time employees, working in hospitals with different shifts during the week, which affect their mandatory attendance graduate programme (usually medical sector graduates serve 3 years in public hospitals or in the army).
4. Moreover, it is perceived amongst the majority of staff in Medical Colleges, that e-learning is not suitable for Medical Education and therefore not worthwhile to invest in embedding ICT into the curriculum.

As in many countries, Medical Education (ME) in Egypt is offered at three levels including Undergraduate ME, Graduate ME, and Continuing ME. Information

technology development has provided a suitable chance for ME, and e-learning in ME is growing day by day. The technology available in the medical field including robots used in surgery, computer simulations, radiology information systems and virtual laboratories helped the development of virtual ME (Wong *et al.* 2010). However, a recent survey at a medical college in a developing country is claiming that the transformation for virtual ME seems to be difficult, as education in the clinical field it is hardly possible without experience with the patients and their diseases in real situations (Emami 2009). Meanwhile, e-learning may be of benefit in basic sciences ME where learning through web as a complementary method can also enhance student learning. Similarly, Albarrak *et al.* (2010) explained that the nature of medical education adds more challenges and requirements to the LMS. He indicated that the medical OSS LMS used should be able to manage different type of data (especially those used in Radiology including X rays, MRI files, Doppler) and accommodate huge amount of information (surgery videos, patient history cases, detailed patient examination, etc.)

The author disagrees with those statements. Medical Education is similar to any educational process where the triangle of learner, teacher, and curriculum exist. For the basic sciences where no clinical activities occur, learning through the web will certainly bring all e-learning promises to medical students. For the clinical part, it is similar to the practical part in any other sector (engineering, agriculture, aviation, etc.) where students need to practice and to perform certain activities to demonstrate knowledge, skills, and mastery of the situation. This argument is supported by the results found in many studies such as Nicholson *et al.* (2006) who demonstrated that a computer-based 3-D anatomical model enhanced medical students' learning of ear anatomy and the study made by Solyar *et al.* (2008) who demonstrated that the use of the endoscopic sinus surgery simulator had shown promising results in improving resident skills in sinus surgery.

E-learning will not replace hands-on activities; however, it may help learners in practical situations to enhance the skills required through simulation, virtual labs, and interactive animated applications. For example, animation in medical education has been described in many studies for teaching a wide variety of medical areas. It has been

studied for teaching histology (Brisbourne *et al.* 2002), cellular and molecular processes (McClean *et al.* 2005, Thatcher 2006), and human anatomy (Jacobs *et al.* 2003). In clinical teaching, animation has been used to facilitate learning in physical examinations (Houck *et al.*2002), surgical techniques (Henderson and Ali 2007, Bade *et al.* 2006) and anesthetic procedures (Lim *et al.* 2005).

At organisational level, medical colleges, especially in developing countries, use of simulation and virtualisation can provide solutions in overcoming the major problems of over-crowded labs and limited resources. Students can learn the concept and clinical cases at ease outside the clinic and then practice the skills afterward inside the clinic. This could be the solution to many problems such as over-crowding in labs, limited time to investigate cases, and limited laboratory equipments.

EGYPTIAN UNIVERSITIES CHALLENGE

The challenge to Egyptian universities and colleges in the 21st century is not to decide why they should have e-learning programmes, but to decide how to design and implement these programmes. Understanding how to plan a successful programme will be essential to their success (Mohammad, 2008). Though many factors related to organisational structure, academic policies and regulations, pedagogical objectives, infrastructures readiness, e-content preparations, and interested parties' acceptance (i.e. teachers and students) among others should be considered. Technology plays a major role in e-learning implementation. To implement e-learning successfully, it will require administrators, faculty, and technology experts to work as a team to choose and select the most appropriate technology to fit-in with university vision and mission. Only with such broad involvement from all stakeholders can a traditional college create the infrastructure required to support a successful e-learning programme implementation (McClure and Woolum 2006). Selecting the technology is one of the most important factors to the success of e-learning implementation due to the numerous critical factors associated with this decision (Dewever 2006). Factors such as cost, user friendly, interoperability, acceptance from users, and alignment with education objectives would definitely affect the whole e-learning programme implementation, if poor procurement was pursuit for technology selection.

Thus, for Egyptian universities and colleges willing to implement e-learning programmes in their education system, it is becoming increasingly important to adopt a rigorous evaluation, selection and procurement process that balance cost and technical criteria with non technical criteria to fulfill their pedagogical and academic objectives.

APPENDIX II - INTERVIEWEES

	Case 1 ALMEDCO	Case 2 ALDENCO	Case 3 MAMEDCO
Administrative	1.1 Dean 1.2 Vice dean for educational affairs	2.1 Dean 2.2 Vice dean for educational affairs	3.1 Dean 3.2 Vice dean for educational affairs
Pedagogical	1.3 Head of Medical Education 1.4 Director of Unit of Quality in Education	2.3 Local Director of QAAP	3.3 Local Director of QAAP
Technical	1.5 Director of E-learning Unit 1.6 E-learning consultant	2.4 Head of E-learning Committee 2.5 e-learning consultant	3.4 Director of E-learning unit

APPENDIX III - INTERVIEW AGENDA

The questionnaire aims to address the following issues:

1. To obtain general institution information
2. To obtain technical information
3. To identify business information (e.g. benefits, barriers and costs associated with OSELA adoption)

Name:			
Position:			
Institution:			
Address:			
Telephone:		Fax:	
E-mail:			
Web site:			

This questionnaire is divided into four sections:

Section A – General Institution Information

Section B – Technical Information

Section C- Business Information

Section D- Framework Assessment

SECTION A – GENERAL INSTITUTION INFORMATION

A.1 How many people are employed by your institution? (approx.)

Administrative		
Technical	IT/IS related	
	e-learning related	
Academic	Professors	
	Assistant Professors	
	Teacher	
	Assistant Teacher	
	GTA	

A.2 How many departments and units does your institution have?

Administrative	
Technical	
Academic	

A.3 How many colleges and institutions does your University have?

A.4 What is the main academic discipline/domain of your institution?

A.5 How many colleges and institutions with similar discipline exist in your country?

A.6 Does your institution have other branches in other cities or countries? If yes, please specify

A.7 How many programmes do you run in your institute? How many students do you have in each?

	Programme	**Total**	**Local Students**	**International Student**
Undergraduate				
Postgraduate				

SECTION B – TECHNICAL INFORMATION

B.1 How is the organisation of your IT infrastructure? Is it centralized in the institution level or in the university level?

B.2 How many information systems exist in your institution? Please specify nature of system (proprietary, open source), types (operating systems, databases, etc.) and numbers:

B.3 What problems did you have before adopting OSELA?

B.4 What was the adoption and growth path you envisioned?

B.5 Have you defined and agreed upon a roadmap for implementation?

B.6 Have you defined a plan to build an integrated learning environment?

B.7 What were the most important are attributes in favor of OSELA over Proprietary applications? Drivers to choose OSELA.

B.8 What are the main features associated with the administrative features of the adopted OSELA?

B.9 What were the most important Applications to fulfill the administrative needs? Please specify your adoption decision.

B.10 What are the main features associated with the learning features of the adopted OSELA?

B.11 What are the most important Applications to fulfill the Learning needs in your institution? Please specify your adoption decision.

B.12 What are the main features associated with the technical needs in your institution?

B.13 What are the most important infrastructure Applications to fulfill your Technical needs? Please specify your adoption decision.

SECTION C – BUSINESS INFORMATION

C.1 Who initiated the idea for Adopting OSELA?

C.2 Have you consulted a wide enough group of stakeholders?

C.3 What are the main motivations/drivers for adopting OSELA?

C.4 Are those drivers clearly defined and distinct?

C.5 What problems did your institution face before adopting OSELA?

C.6 What kind of e-learning have your institution implemented lately? on which level (undergraduate, post graduate. community programme, etc)

C.7 What was the impact from the adoption of OSELA? Please explain:

Impact on Administration:

Impact on Faculty:

Impact on Students:

C.8 What are the main costs associated with the adoption of OSELA in your Institution? and what are their rating values?

Category	Cost Item	Description	Value
Technology Costs	Initial Licence		
	Annual Licence		
	Maintenance		
	Upgrade		
	Hardware Costs		
	Web hosting Costs		
	Other…..		
Human Costs	Support		
	Integration & Interoperation		
	Customisation & Localisation		
	Consultancy Costs		
	IT employee salaries		
	Academic Staff training		
	Other…..		
Organisation Costs	Managing resistance of change		
	Reorganisation of the curriculum		
	Restructuring of the organisation		
	Business process reengineering		
	Other…..		

C.9 What benefits are derived from OSELA adoption in your institution?

C.10 What are the barriers to OSELA adoption in you institution?

D1 - How important are the following applications to the correspondent application purpose and e-learning mode categories?

		Application Purpose			e-learning mode		
Category	**Applications sub category**	Industrial Focused	Education Focused	General	Blended e-learning	Online Blended e-learning	Self Based e- Learning
Learning	Learning management system						
	e-Library Systems						
	Social Learning Systems						
	Portfolio Management Systems						
Supportive	Research Administration						
	Conferences Management						
	Journal Administration Systems						
	Portal Administration Systems						
	Office Productivity & Web Browsers						
Business	Student Information System						
	Facility and Class Management						
	Financial Management						
	Human Resources Management						
Infrastructure	Operating Systems						
	Identity Management System						
	Web Servers						
	Database Servers						
	Unified Communication Systems						

D2 - How important are the following requirements when selecting OSELA applications?

Application Requirements	Description	Rate
Maturity	Maturity shows the stability of open source application. It deals with its continuous growth in term of development activities (correcting and improving or enhancing) and community activities.	
Community	Community is the number of people and organisations existing around open source software and participates in its life-cycle. Community participation includes: filing bug reports, giving feedback on functionality the user would like to be added and putting the software through extensive testing and Quality Assurance (QA).	
Longevity	The longevity of a product is a measure of how long it has been around. It says something about a project's stability and chance of survival.	
Licence	The Licences in the Open Source world reflect where copyright is used to ensure free software and their derivative works remain free.	
Support	Support covers several areas: training users on how to use the product, installing the product, and answering users who have specific problems trying to use a working product	
Documentation	As community keeps in updating and evolving the software, it becomes very essential to keep documentation up-to-date and useful for others that often rely on internal resources to deploy, debug and maintain the software.	
Security	Security is one of the main issues when software is evolved. The openness of open source makes it safer as communities that involve end users, developers, support staff lead vulnerabilities in the code to be found sooner	
Functionality	Functionality is the ability of the application to fulfill the requirements and meet the business needs of the customer. It means that the application has the elements, tools, and features required for the business case.	
Interoperability	Interoperability refers to the ability of the application to operate and work with the other applications in use or planed to be used. The software architecture should fit the institution's technology and interoperability profile. Any institution's profile often includes a variety of commercial, custom made and open software. Closely connected to standards is the key to interoperability with other applications.	
Customisability	Customisability measures how well one can customise the product to fit into specific environment and how well a programme can be used to handle unusual circumstances that it wasnot originally designed for.	
IT and Web profile	The flexibility offered by the software to run on a multiple profile of servers, operating systems and databases to avoid unneeded and redundant servers and to keep low cost of ownership.	

a. Public universities

1	**Cairo University**		**Est. 1908**
No. of Students	**200,000**	No. of Faculties	**26**
No. of Local Branches	-	No. of Int'l Branches	-
Web site:	http://www.cu.edu.eg		

List of Faculties

1. Faculty of Engineering
2. Faculty of Medicine
3. Faculty of Nursing
4. Faculty of Pharmacology
5. Faculty of Agriculture
6. Faculty of Science
7. Faculty of Law
8. Faculty of Mass Communication
9. Faculty of Archaeology
10. Faculty of Arts
11. Faculty of Computers and Information System
12. Faculty of Physiotherapy
13. Faculty of Oral and Dental Medicine
14. Faculty of Veterinary Medicine
15. Faculty of Dar El-Ulum
16. Faculty of Kindergarten
17. Faculty of Specialized Education
18. Faculty of Commerce
19. Faculty of Regional and Urban Planning
20. Faculty of Economics and Political Science

2	**Ain Shams University**		**Est. 1950**
No. of Students	**170,000**	No. of Faculties	**17**
No. of Local Branches	-	No. of Int'l Branches	-
Web site:	http://www.shams.edu.eg/		

List of Faculties

1. Faculty of Agriculture
2. Faculty of Arts
3. Faculty of Commerce
4. Faculty of Education
5. Faculty of Engineering
6. Faculty of Dentistry
7. Faculty of Languages
8. Faculty of Law
9. Faculty of Medicine
10. Faculty of Nursing
11. Faculty of Pharmacy
12. Faculty of Science
13. Women's College
14. Faculty of Specific Education
15. Faculty of Computer and Information Sciences
16. Institute of Environmental Studies and Research
17. Institute of Postgraduate Childhood

3	Alexandria University		Est. 1942
No. of Students	175,590	No. of Faculties	17
No. of Local Branches	2	No. of Int'l Branches	2
Web site:	http://www.alex.edu.eg		

List of Faculties

1. Faculty of Arts
2. Faculty of Science
3. Faculty of Dentistry
4. Faculty of Veterinary Medicine
5. Faculty of Kindergarten
6. Faculty of Education
7. Faculty of Law
8. Faculty of Commerce
9. Faculty of Pharmacy
10. Faculty of Tourism & Hotels
11. Faculty of Engineering
12. Faculty of Medicine
13. Faculty of Nursing
14. Faculty of Agriculture
15. Faculty of Specific Education
16. Faculty of Physical Education-Males
17. Faculty of Physical Education-Females

4	Al-Minya University		Est. 1976
No. of Students	N/A	No. of Faculties	16
No. of Local Branches	-	No. of Int'l Branches	-
Web site:	http://www.minia.edu.eg/		

List of Faculties

1. Faculty of Agriculture
2. Faculty of Education
3. Faculty of Sciences
4. Faculty of Arts
5. Faculty of Engineering
6. Faculty of Nursing
7. Faculty of Tourism and Hotels
8. Faculty of Al-Alsun
9. Faculty of Pharmacy
10. Faculty of Computer Sciences
11. Faculty of Specific Education
12. Faculty of Kindergarten
13. Faculty of Medicine
14. Faculty of Dentistry
15. Faculty of Physical Education
16. Faculty of Dar Al-Uloom

5	Assiut University		Est. 1957
No. of Students	N/A	No. of Faculties	14
No. of Local Branches	1	No. of Int'l Branches	-
Web site:	http://www.aun.edu.eg/		

List of Faculties

1. Faculty of Agriculture
2. Faculty of Arts
3. Faculty of Commerce
4. Faculty of Computers & Informatics
5. Faculty of Education
6. Faculty of Engineering
7. Faculty of Law
8. Faculty of Medicine
9. Faculty of Nursing
10. Faculty of Pharmacy
11. Faculty of Sciences
12. Faculty Social Work
13. Faculty Specific Education
14. Faculty Veterinary Medicine

6	Banha University		Est. 2005
No. of Students	60,500	No. of Faculties	14
No. of Local Branches	-	No. of Int'l Branches	-
Web site:	http://www.benha-univ.edu.eg/		

List of Faculties

1. Faculty of Engineering
2. Faculty of Commerce
3. Faculty of Arts
4. Faculty of Law
5. Faculty of Medicine
6. Faculty of Veterinary Medicine
7. Faculty of General Education
8. Technical Institute of Nursing
9. Faculty of Agriculture
10. Faculty of Sciences
11. Faculty of Nursing
12. Faculty of Computers and Information
13. Faculty of Physical Education
14. Faculty of Specific Education

7	Beni-Suef University		Est. 2005
No. of Students	N/A	No. of Faculties	12
No. of Local Branches	-	No. of Int'l Branches	-
Web site:	http://www.bsu.edu.eg		

List of Faculties

1. Faculty of Law
2. Faculty of Art
3. Faculty of Medicine
4. Faculty of Sciences
5. Faculty of Pharmacy
6. Faculty of Industrial education
7. Faculty of Physical Education
8. Faculty of Nursing
9. Faculty of Engineering
10. Faculty of Veterinary
11. Faculty of Education
12. Faculty of Commerce

8	Fayoum University		Est. 2005
No. of Students	N/A	No. of Faculties	14
No. of Local Branches	-	No. of Int'l Branches	-
Web site:	http://www.fayoum.edu.eg/		

List of Faculties

1. Faculty of Education
2. Faculty of Agriculture
3. Faculty of Engineering
4. Faculty of Social Work
5. Faculty of Sciences
6. Faculty of Early Childhood Education
7. Faculty of Computers and Information
8. Faculty of Specific Education
9. Faculty of Archaeology
10. Faculty of Medicine
11. Faculty of Arts
12. Faculty of Dar Al-Uloom
13. Faculty of Tourism & Hotels
14. Faculty of Nursing

9	Helwan University		Est. 1975
No. of Students	N/A	No. of Faculties	17
No. of Local Branches	1	No. of Int'l Branches	-
Web site:	http://www.helwan.edu.eg		

List of Faculties

1. Faculty of Social Work
2. Faculty of Education
3. Faculty of Sciences
4. Faculty of Pharmacy
5. Faculty of Law
6. Faculty of Engineering
7. Faculty of Community Service
8. Faculty of Computers and Information
9. Faculty of Commerce and business administration
10. Faculty of Applied arts
11. Faculty of Art Education
12. Faculty of Music education
13. Faculty of Physical Education-Males
14. Faculty of Physical Education-Females
15. Faculty of Home Economics
16. Faculty of Tourism and Hospitality
17. Faculty of Fine Arts

10	Mansoura University		Est. 1972
No. of Students	N/A	No. of Faculties	17
No. of Local Branches	1	No. of Int'l Branches	-
Web site:	http://www.mans.eun.eg/		

List of Faculties

1. Faculty of Medicine
2. Faculty of Education
3. Faculty of Sciences
4. Faculty of Pharmacy
5. Faculty of Dentistry
6. Faculty of Commerce
7. Faculty of Law
8. Faculty of Veterinary Medicine
9. Faculty of Physical Education
10. Faculty of Engineering
11. Faculty of Agriculture
12. Faculty of Nursing
13. Faculty of Arts
14. Faculty of Kindergartens
15. Faculty of Special Education
16. Faculty of Tourism and Hotels
17. Faculty of Computer Science & Information Systems

11	Minufiya University		Est. 1976
No. of Students	N/A	No. of Faculties	15
No. of Local Branches	-	No. of Int'l Branches	-
Web site:	http://www.menofia.edu.eg/		

List of Faculties

1. Faculty of Education
2. Faculty of Agriculture
3. Faculty of Commerce
4. Faculty of Law
5. Faculty of Arts
6. Faculty of Electronic Engineering
7. Faculty of Computers and Information
8. Faculty of Tourism and Hotel
9. Faculty of Medicine
10. Faculty of Nursing
11. Faculty of Sciences
12. Faculty of Specific Education
13. Faculty of Domestic Economics
14. Faculty of Veterinary Medicine
15. Faculty of Physical Education

12	Port Said University		Est. 2009
No. of Students	N/A	No. of Faculties	8
No. of Local Branches	-	No. of Int'l Branches	-
Web site:	http://www.psu.edu.eg/		

List of Faculties

1. Faculty of Engineering
2. Faculty of Commerce
3. Faculty of Education
4. Faculty of Physical Education
5. Faculty of Nursing
6. Faculty of Sciences
7. Faculty of Kindergarten
8. Faculty of Specific Education

13	Sohag University		Est. 2006
No. of Students	40,000	No. of Faculties	9
No. of Local Branches	-	No. of Int'l Branches	-
Web site:	http://www.sohag-univ.edu.eg/		

List of Faculties

1. Faculty of Agriculture
2. Faculty of Arts
3. Faculty of Commerce
4. Faculty of Education
5. Faculty of Engineering
6. Faculty of Medicine
7. Faculty of nursing
8. Faculty of Science
9. Faculty of Veterinary Medicine

14	South Valley University		Est. 1994
No. of Students	45,000	No. of Faculties	12
No. of Local Branches	1	No. of Int'l Branches	-
Web site:	http://www.svu.edu.eg/		

List of Faculties

1. Faculty of Sciences
2. Faculty of Education
3. Faculty of Arts
4. Faculty of Commerce
5. Faculty of Agriculture
6. Faculty of Medicine

6.

7. Faculty of Law
8. Faculty of Nursing
9. Faculty of Engineering
10. Faculty of Veterinary Medicine
11. Faculty of specific education
12. Faculty of Physical education

15	Suez Canal University		Est. 1976
No. of Students	21,325	No. of Faculties	17
No. of Local Branches	2	No. of Int'l Branches	-
Web site:	http://scuegypt.edu.eg/		

List of Faculties

1. Faculty of Engineering
2. Faculty of Agriculture
3. Faculty of Sciences
4. Faculty of Education
5. Faculty of Medicine
6. Faculty of vet. Medicine
7. Faculty of Commerce
8. Faculty of Tourism and Hotels
9. Faculty of Industrial education
10. Faculty of Dentistry
11. Faculty of Pharmacy
12. Faculty of Arts
13. Faculty of Nursing
14. Faculty of Education
15. Faculty of computer Sciences
16. Faculty Of Petroleum And Mining Engineering
17. Faculty Of Environmental Agricultural Sciences

16	Tanta University		Est. 1972
No. of Students	58,250	No. of Faculties	11
No. of Local Branches	-	No. of Int'l Branches	-
Web site:	http://www.tanta.edu.eg		

List of Faculties

1. Faculty of Pharmacy
2. Faculty of Dentistry
3. Faculty of Education
4. Faculty of Agriculture
5. Faculty of Education
6. Faculty of Commerce
7. Faculty of Specific Education
8. Faculty of Medicine
9. Faculty of Sciences
10. Faculty of Arts
11. Faculty of Engineering

17	Zagazig University		Est. 1974
No. of Students	154,700	No. of Faculties	15
No. of Local Branches	-	No. of Int'l Branches	-
Web site:	http://www.zu.edu.eg/		

List of Faculties

1. Faculty of Pharmacy
2. Faculty of Medicine
3. Faculty of Commerce
4. Faculty of Arts
5. Faculty of Education
6. Faculty of Law
7. Faculty of Veterinary Medicine
8. Faculty of Engineering
9. Faculty of Nursing
10. Faculty of Agriculture
11. Faculty of Sciences
12. Faculty of Specific Education
13. Faculty of Physical Education-Males
14. Faculty of Physical Education-Females
15. Faculty of Computers and Information

18	Kafrelsheikh University		Est. 2006
No. of Students	**52,000**	No. of Faculties	**7**
No. of Local Branches	-	No. of Int'l Branches	-
Web site:	http://www.kfs.edu.eg		
List of Faculties			
1. Faculty of Education 2. Faculty of Agriculture 3. Faculty of Engineering 4. Faculty of Veterinary Medicine		5. Faculty of Commerce 6. Faculty of Arts 7. Faculty of Law	

* Source: Egyptian Universities Network Portal (www.eun.edu.eg) - Last accessed October 2010

b. Private Universities

	University	List of Faculties
1	**Akhbar El Yom Academy**	**4 Faculties** 1. Faculty of Engineering 2. Faculty of Journalism 3. Faculty of computer since and information technolc 4. Faculty of Management
	Website:	www.akhbaracademy.edu.eg
2	**Al-Ahram Canadian University**	**4 Faculties** 1. Faculty of Business Administration 2. Faculty of Pharmacy 3. Faculty of Mass Communication 4. Faculty of Computer Science & IT
	Website:	www.acu.edu.eg
3	**Alamein University**	**3 Faculties** 1. Faculty of Engineering 2. Faculty of Computer Science 3. Faculty of Business marketing
	Website:	www.alamein.edu.eg
4	**American University**	**6 Faculties** 1. School of Business, Economics & Communications 2. School of Humanities and Social Sciences 3. School of Global Affairs and Public Policy 4. School of Sciences and Engineering 5. School of Continuing Education 6. Graduate School of Education
	Website:	www.aucegyp.edu.eg

5	**Arab Academy for Science and Technology and Maritime Transport**	**6 Faculties** 1. Maritime Transport & Technology 2. Engineering & Technology 3. Management & Technology 4. Computing & Information Technology 5. Graduate School of Business 6. International Transport & Logistics
	Website:	www.aast.edu
6	**British University**	**4 Faculties** 1. Faculty of Engineering 2. Faculty of Computer Science 3. Faculty of Business Administration 4. Faculty of Nursing
	Website:	www.bue.edu.eg
8	**Canadian International College**	**3 Faculties** 1. School of Engineering 2. School of Business 3. School of Mass Comunnication
	Website:	www.cic-cairo.com
9	**Delta University for Science and Technology**	**2 Faculties** 1. Collage of Engineering 2. School of management
	Website:	www.deltauniv.edu.eg
10	**Egyptian Russian University**	**2 Faculties** 1. Faculty of Pharmacy 2. Faculty of Engineering
	Website:	www.eruegypt.com

11	**El Asher University**	**3 Faculties** 1. Faculty of Pharmacy 2. Faculty of Nursing 3. Faculty of Engineering
	Website:	www.elasheruniversity.com
12	**El Shorouk Academy**	**4 Faculties** 1. Faculty of Engineering 2. Faculty of Business Administration 3. Faculty of Information systems 4. Faculty of Computer Science
	Website:	www.elshoroukacademy.edu.eg
13	**Future University**	**6 Faculties** 1. Faculty of Pharmacy 2. Faculty of Dentistry 3. Faculty of Engineering 4. Faculty of Economics & political 5. Faculty of Computer Science 6. Faculty of Business Administration
	Website:	www.futureuniversity.edu.eg
14	**German University**	**7 Faculties** 1. Faculty of Applied Arts & Design 2. Faculty of Engineering and Materials Science 3. Faculty of Information Engineering and Technology 4. Faculty of Management Technology 5. Faculty of Media Engineering and Technology 6. Faculty of Pharmacy and Biotechnology 7. Faculty of Postgraduates Studies and Scientific Research
	Website:	www.guc.edu.eg
15	**Heliopolis University**	**7 Faculties** 1. Sustainable Engineering 2. Sustainable Business & Economics 3. Health Sciences & Practices 4. Sustainable Agriculture & Food Sciences

		5. Social Sciences & Humanities 6. Media & Communications 7. Applied Arts
	Website:	N/A
16	**Higher Technological Institute**	**5 Faculties** 1. Computer Science Department 2. Engineering Department 3. Technological Management and Information (Arabic) 4. Technological Management and Information (English) 5. Technological Management and Information (Arabic)
	Website:	www.hti.edu.eg
17	**International Academy for Media Sciences**	**2 Faculties** 1. Media Science department 2. Media Engineering department
	Website:	www.iams.edu.eg
18	**Misr International University**	**8 Faculties** 1. Faculty of Pharmacy 2. Faculty of Business Administration 3. Faculty of Architecture Engineering 4. Faculty of Electronics & communication Engineering 5. Faculty of Alsun 6. Faculty of Mass communication 7. Faculty of Computer Science 8. Faculty of Dentistry
	Website:	www.miuegypt.edu.eg
19	**Misr University for Science and Technology**	**12 Faculties** 1. College of Medicine 2. College of Oral and Dental Surgery 3. College of Physiotherapy 4. College of Pharmacy and Pharmaceutical Manufacturing 5. College of Biotechnology 6. College of Engineering

		7. College of Information Technology 8. College of Business Administration & Economics 9. College of Mass Media & Communications 10. College of Foreign Languages and Translation 11. College of Applied Medical Sciences 12. College of Archaeology and Tourist Guidance
	Website:	www.must.edu
20	**Modern Academy**	**4 Faculties** 1. Computer Science Department 2. Business Administration Department 3. Managerial Information Systems Department 4. Basic Science Department
	Website:	www.**modern-academy-maadi**.com
21	**Modern Sciences and Arts University**	**8 Faculties** 1. Faculty of Pharmacy 2. Faculty of Engineering 3. Faculty of Biotechnology 4. Faculty of Management 5. Faculty of Mass Communications 6. Faculty of Computer Science 7. Faculty of Dentistry 8. Faculty of Languages
	Website:	www.msa.eun.eg
22	**Nahda University**	**6 Faculties** 1. Faculty of Oral and Dental Medicine 2. Faculty of Pharmaceutical Science 3. Faculty of Marketing and Business Administration 4. Faculty of Computer Science 5. Faculty of Mass Communication 6. Faculty of Engineering
	Website:	www.nahdauniversity.org
23	**Nile University**	**4 Faculties** 1. School of Communications and Information Techn 2. Graduate School of Management of Technology (M

		3. School of Business 4. School of Engineering & Applied Sciences
	Website:	www.nileu.edu.eg
24	**6th of October University**	**14 Faculties** 1. Faculty of Medicine 2. Faculty of Pharmacy 3. Faculty of Dentistry 4. Faculty of Applied Medical Sciences 5. Faculty of Engineering 6. Faculty of Physical Therapy 7. Faculty of Information Systems & Computer Science 8. Faculty ofApplied Arts 9. Faculty of Media & Mass Communication 10. Faculty of Economics & Management 11. Faculty of Languages & Translation 12. Faculty of Education 13. Faculty of Social Science 14. Faculty of Hotel Management & Tourism
	Website:	www.o6u.edu.eg
25	**Pharos University**	**7 Faculties** 1. Faculty of dentistry 2. Faculty of pharmacy 3. Faculty of engineering 4. Faculty of languages and translation 5. Faculty of business administration 6. Faculty of legal studies 7. Faculty of tourism and hospitality management.
	Website:	www.pua.edu.eg/
26	**Science Valley Academy**	**5 Faculties** 1. Advising & Registration department 2. Educational System department 3. Management Studies department 4. Information Systems department 5. Engineering department

	Website:	www.sva.edu.eg
27	**Sinai University**	**7 Faculties** 1. Faculty of Dentistry 2. Faculty of Business Administration 3. Faculty of Engineering Sciences 4. Faculty of Information System and Computer Scien 5. Faculty of Media Technology 6. Faculty of Pharmacy and Pharmaceutical Industries 7. Faculty of Humanities
	Website:	www.su.edu.eg
28	**Université Française d'Égypte**	**3 Faculties** 1. Faculty of Applied Languages 2. Faculty of Management and Information System 3. Faculty of Engineering
	Website:	www.ufe.edu.eg

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